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WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.
LIST OF SECRETARIES—
General Secretary: E. A. Pilkington, Brook House, Sheepbridge, Chesterfield.
Manchester: A. Harrison, 705, Manchester Road, Castleton.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Cardiff: H. Griffiths, Messrs. J. Williams & Sons, Ltd., Globe Foundry, Cardiff.
Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.
Scottish: J. Paterson, Royal Technical College, Glasgow.
London: T. Murphy, 180, Gray's Inn Road, London, W.C.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.

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NOTES AND COMMENTS.

The Economic Utilisation of Labour.

Since the days when Plato enunciated his conception of ideal civic and social development—ideals which are more frequently criticised than understood—there has existed a gradually growing consciousness throughout all civilised races that the efficient development and utilisation of individual capacity is the ultimate governing factor in national progress. The essential egoism, however, involved in the development of individual capacity, unfortunately tends to obscure the relations between individual and community; so that we now find existing the anomalous demands for higher national progress and also a measure of individual liberty and rights that totally disregards the effect on the development and efficiency of any but the individual immediately concerned. It is not our intention at the moment, however, to deal with this subject in its wide aspect, but rather to discuss briefly the existence of the same tendency, and to a marked degree, in the foundry trade. In a concise and simple, yet forceful and sympathetic manner, the President of the British Foundrymen's Association, at the Leicester Conference last month, touched upon some phases of the same subject—the human problem in the foundry industry. He reminded his hearers that no industry can be in a truly healthy condition unless it interests and elevates the workers engaged in it; and also that no quantity or quality of product can make up for deterioration of the beings engaged. He further uttered a warning against the improper use of machinery—its use in such a way as to stultify the development of capacity in the workers—since on the correct handling of this "human problem" lies the future prosperity of the industry.

It is unfortunate that when such questions are raised, many of those who are most intimately and responsibly concerned dismiss the whole subject with a contemptuous reference to "sloppy sentimentality." But sentiment, as generally understood, is not concerned at all, and may be ruled out of consideration. We would, personally, be quite content to have the subject treated on a strictly business basis—on the basis of productive efficiency and industrial progress—provided the treatment were broad and comprehensive, and looking to the ultimate rather than the immediate results. The matter really resolves itself into this:—Are the trivial and short-sighted attempts at immediate gain on the part of individuals to be allowed to prejudice the prosperity and sap the vitality of the industry generally? That has been the tendency for some time with the foundry trade. It is not a matter of sentiment, but a hard business fact that present conditions (we hope only transient conditions) in the foundry trade are not producing the supply of competent and capable operatives necessary to the maintenance of economic progress. Unlike resources of materials, the labour resources of an industry should not be depleted by use, but should rather be strengthened and increased; and unless the conditions of operation are such as to secure that, then there is something wrong. It is not difficult to find some, at least, of the causes

which are now operating to the depletion of labour resources and capacity in the foundry trade, and not the least of these is neglect of that same "human problem." Were the neglect of that and similar problems such as to result in an absolute deterioration of the workers' capacity, the law of reaction would perforce come into play, since the foundry industry is essential to a number of other industries. But while that very fact of being essential is a certain stimulus to progress, the other factors tend to make the progress the minimum necessary rather than the maximum possible. We must admit, however, that the neglect in question is by no means absolute, for the broader outlook is taken by many firms, with the result that the trade has been able to meet most of the demands made by the advances of engineering. That it has fully met them can scarcely be claimed, at least so far as foundries in general are concerned; while in many cases also, the cost is disproportionate, in view of the advances recently made in the scientific side of metallurgy. For the triumphs hitherto recorded we have to thank individual efficiency, rather than the general standard of the trade's workers.

While on this question of a trade giving proper facilities for the development of capacity in the workers, it may be well to briefly examine the matter from the standpoint of the individual employer. It is often claimed that what might be theoretically proved to be desirable for an industry in the aggregate is not always practicable for the individual undertaking. Granted that that is so, it does not necessarily follow that the conditions which will make for the development of capacity will not also make for economical operation in the individual case. One of the first essentials to be remembered is that the output of a works (both as regards quality and quantity) is affected directly by the capacity of the workers and the conditions of operation. Particularly in such a trade as founding is intelligence and initiative demanded, and though much work may be of a repetition and routine character, even that may be conducted either more or less efficiently, according to conditions. To keep at one job continuously a man whose capacity for development is unquestionably negligible may be excused; but to tie a potentially capable man, such as an apprentice, at one class of work is to rob the trade of that full capacity on the part of the lad which it will later demand.

Now as to the profitable utilisation of competent labour. A feature of the operations in some foundries which must strike an unbiassed observer very forcibly is the total disregard of those factors which permit or prevent efficient operation by capable men. If a £50 machine of any description is installed in the foundry it is expected to turn out such quantity and quality of work as will well justify the outlay; and it is installed accordingly in a suitable position, with the necessary facilities for doing its best. But if a £100-a-year moulder is installed he is probably expected to work in a building sadly deficient in light, with the crudest of facilities, and under such conditions that nearly half his labour is wasted on futile operations by reason of bad organisation, poor materials and inadequate plant. Or he may have to spend 25 per cent. of his time on work that not only could be done better by a £63-a-year labourer, but which also is detrimental to the quality of his more skilled work. The net result is a loss of anything from 10 to 40 per cent. of the possible result of the skilled man's labour. It is admittedly difficult to accurately check the efficiency of workers in a general foundry, but when it is realised that bad conditions and poor equipment may seriously affect the value of the labour of every man in the shop and render prices unprofitable when they might be remunerative, it is not difficult to see what the effect on the foundry trade generally must be when so many foundries are found to come under the above criticism. This claim for conditions of work which will permit the really economical utilisation of the different classes of foundry labour is not a sentimental cry in the interests of the worker; it is a matter of business economy—a matter of hard £ s. d. to the foundry owner.

Cupola Blast.

There appears to be among foundrymen a very imperfect conception of the distinction between velocity and quantity of blast; and many hold that impression that greater area of tuyeres will compensate for lack of velocity. This is distinctly erroneous, however; for though the same amount of air forced into a vacant cylinder might be got by increasing the area of travel (tuyere area) and decreasing the rate of travel (velocity) proportionately, a different result is obtained when operating against the resistance of the cupola's stock or charge. A tuyere discharging air into the centre of an unenclosed pile of coke would probably distribute the air evenly to the atmosphere all round. But a tuyere discharging air into a packed cylinder where the only exit is upwards does not represent a parallel case; for the pressure of the injected air must be in excess of the accommodation afforded by the upward escape before penetration in other directions takes place. It will thus be seen that to increase the number of tuyeres and so increase the area without increasing the pressure is equivalent to increasing the area of upward escape. At the same time, a certain increase of pressure is obtained by merely *enlarging* the tuyeres and maintaining the same blast pressure, since the area of upward escape is not by this means increased to the same extent as by a greater number of tuyeres of unaltered size (presupposing that the tuyeres are distributed round the cupola). It must, however, be remembered that so far as the pressure of blast in the stock itself is concerned, the resistance of the stock has the effect of distributing the air and hence forcing it to the centre as well as other parts, and hence an increase of volume of blast at the same pressure does actually increase the amount supplied to the centre, though not to the same extent as an increase of pressure. Since the scope for expansion of the air is frequently greatest near to the lining; and as the line of the least resistance is followed, in the absence of a velocity directing the blast towards a definite point it will naturally be disseminated before penetrating inwards to the desired extent. The obvious result is inefficient combustion in the centre of the furnace. It will also be obvious that the nature and condition of packing of the charge will have an influence, inasmuch as it will affect the possibility of upward escape of the blast. The difficulty of establishing a definite formula for pressure and quantity lies in the fact that the resistance to the travel of blast varies with the distribution of the tuyeres, the nature and size of the material forming the charge, and the method of packing. It is not surprising, then, that tuyere ratios as quoted by different authorities vary greatly. In one case which came under our notice an increase of tuyere area to the ratio of 1 : 5 gave, apparently, excellent results, though whether an improvement could have been secured by a smaller ratio and greater pressure we cannot say. The case, however, affords a striking contrast to the ratio of 1 : 19.2 arrived at by Bellamy and quoted by Mr. Rhead.

British Foundrymen's Association.

Conference at Leicester.

The eleventh Annual Conference of the British Foundrymen's Association was held at Leicester on Tuesday, Wednesday, and Thursday, May 12, 13, and 14. This was the first visit by the Association to this important industrial centre, and the meeting was in every way a success. About 120 members attended the meeting and other functions, in addition to which a number of visitors were present. The members included the following:—*President*, Mr. S. A. Gimson; *Past-Presidents*, Messrs. R. Buchanan, F.R.S.A. (Birmingham), H. Pilkington, M.I.C.E. (Chesterfield), and C. Jones (Cardiff); *Vice-Presidents*, Messrs. W. Mayer (Dumbarton) and J. Ellis (Luton); *Members of Council*: Messrs. J. E. H. Allbut (Manchester), W. F. Bagnall (Sheffield), G. B. Henderson (Southampton), H. Jewson (East Dereham), T. McFarlane (Shropshire), H. Pemberton (Derby), M. Riddell (Falkirk), J. Smith (South Shields), with F. W. Finch (Gloucester), Treasurer, and E. A. Pilkington (Sheepbridge), Secretary. The other members present were:—Messrs. H. Shillitoe (Potters Bar), F. Gledhill and G. Green (Brighouse), D. Gordon and Alexander Hayes (London), G. K. Barrett (Luton), J. Hawkins (Sheffield), N. J. Pearson (Beeston), G. A. Young (London), S. H. Russell (Leicester), C. Mace, (Birmingham), E. N. Wright (Upton), H. A. J. Rang (Newcastle), R. T. Rolfe (Bedford), A. Morris (Sunderland), J. Simkiss (Manchester), J. Hargreaves (Bury), J. Knowles (Sheffield), J. J. Collin (Sunderland), H. Grandidge (Bury), W. Rawlinson (Manchester), D. Dalrymple (West Bromwich), J. Wharton (Maryport), C. B. Pugh (Walsall), W. T. Davis (Portsmouth), B. F. Sperring (Portsmouth), H. Winterton (Birmingham), G. M. Mather (Ashford, Kent), J. Shaw (Birmingham), H. Mather (Birmingham), D. Landale (Kirkcaldy), J. G. Dobson (Birmingham), B. Hurd (Birmingham), A. Bowman (Burnham-on-Crouch), H. O. Johnson (Manchester), J. Feasey (Lincoln), J. B. Durrans (Sheffield), W. E. Dobson (London), A. Harrison (Manchester), P. Fox-Allin (Birmingham), W. H. Freeman (Gainsborough), J. Kerfoot (Loughborough), J. Lucas (Loughborough), J. Chadwick (Bolton), W. Sykes (Sheffield), W. Roxburgh (Keighley), H. S. Green (London), F. E. Barker (London), L. Laurance (London), J. C. Eaborn (London), J. R. Hyde (Sheffield), F. C. Pulsford (Leicester), F. Penlington (Manchester), A. Sutcliffe (Manchester), J. Bennett (Stroud), F. Cox (London), S. Wright (Leicester), C. Fontaine (Newport, Mon.), H. P. Mason (Oldham), E. Brooksley (Leicester), A. Harley (Coventry), C. Heggie (Birmingham), C. B. Richards, M. E. Gallon (Dunston-on-Tyne), and J. Knowles (Stourbridge).

The meetings took place in one of the lecture halls of the Municipal Technical School, a substantial and well-equipped building in the Newarke, the oldest part of the town.

The PRESIDENT, at the opening of the proceedings, said he thought the members of the Association would all desire, before entering upon the business, to congratulate one of the members of the Council, Dr. T. Swinden, of Sheffield, on having been awarded the Carnegie Gold Medal of the Iron and Steel Institute. (Applause.) The Secretary would convey their congratulations to their Sheffield colleague.

MR. SYDNEY A. GIMSON.
President of the British Foundrymen's Association, 1914-1915.

REPORT OF THE COUNCIL.

The Council reported as follows:—

Six Council meetings were held during the year at Birmingham, Leeds, Manchester, London and Leicester, when members attended from Basford (Stoke), Birmingham, Bolton, Cardiff, Chesterfield, Derby, Dumbarton, Falkirk, Glasgow, Gloucester, Halifax, Horsehay (Shropshire), Leicester, London, Luton, Manchester, North Shields, Sheffield and Warrington.

The Branches are doing excellent work; many interesting Papers have been read and discussed, and visits to various works have been much appreciated by the members. The respective Branches have the following members attached to them:—

	Members.	Associate Members.	Associates	Total.
Birmingham	20 (15)	67 (91)	53 (70)	140
Halifax	15 (21)	38 (49)	60 (60)	113
Lancashire	33 (33)	88 (95)	31 (31)	152
London	52 (43)	64 (51)	17 (15)	133
Newcastle	27 (25)	36 (29)	27 (22)	90
Sheffield	34 (29)	70 (58)	16 (17)	120
Scottish	29 (24)	92 (89)	63 (42)	184

Last year's figures given in brackets.

The total number of members on the roll of the Association is 974 against 923 last year. The mem-

bers consist of 7 honorary life members, 5 life members, 217 members, 486 associate members, and 259 associates. During the year 6 members, 50 associate members and 30 associates resigned or ceased to become members, and 31 members, 74 associate members and 32 associates were elected.

The accounts for the year ended December 31, 1913, are submitted, having been duly audited by Messrs. Frank Creke, Harcourt & Company, Whitehall Chambers, Colmore Row, Birmingham. The total revenue for the year was £470 5s. 2d., and the expenses £399 17s. 4½d., leaving a balance on the year's working of £70 7s. 9½d., which added to a surplus of £116 12s. 8½d. at December 31, 1912, shows a total credit balance of £187 0s. 6d.

Six members of the Council are retiring, and are eligible for re-election. The following are the names:—W. H. Hatfield, G. B. Henderson, J. W. Horne, T. McFarlane, J. Oswald, J. Smith. All have been re-nominated, no other nominees having accepted nomination.

The Secretary of the Special Committee on Apprentice Training reports that the enquiries of the Committee are well in hand, and much useful information is being collected with a view to formulating definite suggestions in the near future. The formal report embodying the conclusions of the Committee will be duly circulated amongst the members. The Branches of the Association are co-operating with the Special Committee, and have formed Branch Committees to collect information and generally represent the interests and special requirements of their respective districts.

At the request of the members, the annual general meeting in 1913 was held in London on June 23 and 24, when seven Papers were read and discussed. Visits were paid to the works of the Great Eastern Railway, Stratford, E.; Messrs. Fraser & Chalmers, Limited, Erith; the Royal Arsenal, Woolwich; and the London General Omnibus Company, Walthamstow Factory. The above were preceded on the Sunday, June 22, by an enjoyable trip up the Thames by steamboat.

INCOME AND EXPENDITURE ACCOUNT.

January 1 to December 31, 1913.

INCOME.

	£ s. d.	£ s. d.
Subscriptions received		461 7 6
Sale of Books		0 7 0
Bank Interest:—		
General Account	1 13 8	
Halifax Branch	0 0 10	
Scottish „	0 1 8	
		1 16 2
Annual Meeting:—		
Profit on Boat Trip	5 18 6	
Profit on Dinner	0 16 0	
		6 14 6
		£470 5 2

EXPENDITURE.

	£ s. d.	£ s. d.
Postages		30 2 1
Printing and Stationery (including proceedings)		139 14 1
Council and Finance Expenses		25 11 9
Branch Expenses:—		
Birmingham	13 8 5½	
Lancashire	14 0 7	
Sheffield	14 13 7	
Scottish	19 12 1	
Halifax	9 18 5	
London	32 0 6	
Newcastle	17 19 0	
		121 12 7½
Annual Meeting Expenses		8 8 0
Audit Fee		4 4 0
Clerical Assistance		12 10 0
Incidental Expenses		6 0 4
Grant to Apprentices' Committee		5 0 0
Illuminated Address		4 14 6
Honorarium to Secretary		42 0 0
Balance, being excess of Income over Expenditure for the year		70 7 9½
		£470 5 2

Balance Sheet, December 31, 1913.

ASSETS.

	£ s. d.	£ s. d.
Cash in hand:—		
Lancashire	3 18 10	
Sheffield	13 0 7½	
Scottish	44 15 1	
Newcastle	3 12 10	
Birmingham	0 4 7	
London	19 5 10	
General Secretary	91 16 5½	
	£176 14 3	
Less Balance due to Halifax	5 5 0	
		171 9 3
London City and Midland Bank, Ltd.		164 12 10
Furniture and Fittings		15 0 0
		£349 2 1

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions, paid in advance		12 16 6
Sundry Creditors		149 5 1
Surplus as at Dec. 31st, 1912	116 12 8½	
Add excess of Income over Expenditure for year ended December 31st, 1913	70 7 9½	
		187 0 6
		£349 2 1

NOTE.—Nothing is included in these Accounts for Subscriptions in arrear.

F. W. FINCH, *Treasurer.* E. A. PILKINGTON, *Secretary.*

We have examined the above Balance Sheet with the Books and Vouchers of the Association, and find same to be in accordance therewith.

FRANK CREKE, HARCOURT & Co., *Auditors,*
49, COLMORE ROW, BIRMINGHAM

It was agreed to take the report and balance-sheet as read, and its adoption was proposed by MR. W. MAYER.

MR. F. PENLINGTON enquired as to the amount of subscriptions in arrear, also as to the method of dealing with these, and the probability of their being successfully collected.

The PRESIDENT said that the professional auditors had not given details with regard to those figures, but they varied a good deal and the collection of them was at present in the hands of the Branch Secretaries. But it was the practice for any member twelve months in arrears to be reported to the Council, and, if thought proper, their names were struck off. That course had been taken in connection with a number of members during the year.

The report was adopted.

Election of Officers.

MR. W. MAYER (Vice-President) proposed the re-election of Mr. Gimson as President for the ensuing twelve months, and spoke in appreciative terms of his energy and work for the Association.

MR. H. PEMBERTON, in seconding, remarked that when on a previous occasion Mr. Gimson had been nominated he had said he had never served his time at the foundry or been a moulder, and somebody then had added that he hadn't lost much by that. However, he had been an ideal President, and they all knew the ability, kindness and tact with which he had handled the general meetings, while all the Branches had profited by his visits and his valuable advice and encouragement.

The election was carried with acclamation.

The PRESIDENT, in acknowledging the compliment, said he greatly valued that honour, and the kind expressions of the speakers, which he did not think he deserved. That support, however, was of great value to him in the discharge of his duties, and he felt grateful and proud to hold the position of President of the British Foundrymen's Association. During the past year he had endeavoured to visit as many Branches of the Association as he could and had travelled a good deal up and down the country. He proposed to continue that during

the coming year and generally to do his best for the Association.

The PRESIDENT proposed the re-election of Mr. W. Mayer as senior Vice-President. Mr. Mayer had required a good deal of persuasion to accept re-election, but they were sure that at the proper time he would make a most popular President. His happy relations with all of them, and his help in the practical discussions, were very valuable.

MR. H. PILKINGTON seconded, remarking that they were all very glad that their Scottish confreres had come so well into line. To himself as a former President it was a matter of special satisfaction that the Association was now so large and thoroughly consolidated. Mr. Mayer would give added strength to the Association.

MR. MAYER was cordially elected to the position. In acknowledging, he said that if Anno Domini did not follow him too fast (laughter) he would do his best to help forward the progress of the Association and also of the Scottish Branch, of which he had every hope that the membership would be almost doubled in the not very distant future.

MR. J. SMITH proposed, and MR. F. J. COOK seconded, the re-election of Mr. J. Ellis (Luton) as junior Vice-President. The vote was carried unanimously.

MR. ELLIS, in acknowledging, said he could assure them that the Association would always have a very large place in his heart.

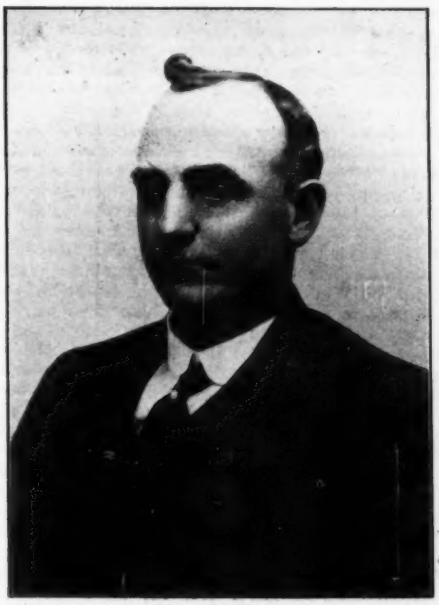
On the proposition of MR. C. JONES, seconded by MR. H. JEWSON, the Treasurer of the Association (Mr. F. W. Finch) was cordially re-elected. Mr. Jewson remarked that their Treasurer had served them splendidly in the past, and the President added that they looked on Mr. Finch as almost the father of the Association, and were delighted that he was willing to serve them again.

MR. FINCH, acknowledging, assured the members that the service of the Association would, to the end of his days, be a labour of love.

The PRESIDENT proposed the re-election of the Secretary, reminding the meeting that when Mr. E. A. Pilkington was elected to the post a year ago there was a certain amount of quite legitimate criticism as to the way in which the Council had put forward the nomination, although that had nothing to do with any objection to Mr. Pilkington. In the course of the discussion, it was then said that the new Secretary might go on a kind of trial run. He, as President, had had a good deal to do with the Secretary's work during the past twelve months, and he could assure them that in every way Mr. Pilkington had proved himself a most suitable man. The election, he reminded them, carried with it an honorarium of forty guineas.

MR. BUCHANAN seconded and the election was carried, the SECRETARY briefly acknowledging the compliment.

MR. W. MAYER.
(*Senior Vice-President.*)



MR. J. ELLIS.
(*Junior Vice-President.*)

The PRESIDENT said they would all desire to recognise the fine work done by Mr. Jones, the late President, by the presentation of an engrossed and illuminated address, and they proposed to pay a similar compliment to Mr. Allbut, the late Secretary. Unfortunately, it was remembered too late for the presentation to be made at the present meeting, and would therefore have to be postponed until next year.

On the proposition of MR. COOK, seconded by MR. RIDDELL, Messrs. Frank Creke, Harcourt & Company, Birmingham, were re-elected Auditors.

The PRESIDENT reminded the meeting of the decision a year ago to reduce the Council from fifteen to ten. Under that arrangement five would have to be re-elected, the retiring members being Dr. W. H. Hatfield, Mr. G. B. Henderson, Mr. J. W. Horne, Mr. T. McFarlane, Mr. J. Oswald and Mr. J. Smith.

On a vote being taken it was announced that the

following had been elected:—Dr. Hatfield and Messrs. G. B. Henderson, T. McFarlane, J. Oswald and J. Smith. The President pointed out that under the rule reducing the number of the Council the different Branches could elect representatives, and therefore London could re-elect Mr. Horne.

The PRESIDENT then proceeded to deliver his address as follows:—

Presidential Address.

I shall ask your attention for only a very short time, as important papers and discussions are to follow my address; especially as I gave you last year the message I feel most keenly about, I shall say little now.

First, I offer you a very hearty welcome to this old, but healthy and growing town. It is not a great engineering centre like the other towns and cities where our conferences have been held; still, important engineering work is being carried out here, and in the near neighbourhood, as you will find out during the Conference, and no engineering of any consequence can go on without the help of foundrymen, so I hope you will find Leicester not an uninteresting place to visit. We pride ourselves on our industry being a very ancient one; Leicester, too, is ancient, one of the oldest towns in Great Britain. Men of the Bronze Age lived here, and at the Museum you can see one of the moulds in which they cast their bronze implements. Probably early men from Europe passed through this place on their way to search for gold in Ireland, the Klondyke of those days. The Britons had a camp here, and the Romans built a considerable city, of which to-day we find many remains. From those days on to the present, Leicester has had a continuous and important history. The first Parliament was summoned by Simon de Montfort from his castle here, the Great Hall of which is still standing. To-day the town is industrially and commercially prosperous, it is well governed, clean and a very pleasant place to live in; altogether we pride ourselves on having one of the most attractive manufacturing towns, with a go-ahead population, keenly alive, inclined to rebellion against unreasonable authority, and with a fine tradition of independence and courage. We have our problems of poverty, misery and ugliness—less than in some towns, but still far too prevalent—and we have, too, our hopes and ideals of the future town more beautiful than anything we know to-day and with preventable misery reduced to the lowest possible point.

It seems in some ways an impertinence that I, no longer actively engaged as a founder, should address you as your President. Still, I have had many years in the trade; I still take a keen interest in it, and there may be something in the old saying that "onlookers see most of the game." You will, I know, forgive me if I say something that may seem to you unpractical. No one is bound to agree with me; I only ask for thought on the human problem in our industry. Thought and research work on that problem will be as surely repaid as in moulding, pattern-making, machine work, metallurgy, or any of the practical workshop questions which demand our attention.

I am satisfied that no industry can be in a truly healthy condition unless it interests and elevates all the workers engaged in it. No quantity or quality of produce can make up for deterioration of the human beings engaged. Architecture reached its highest development and gave us the grandest buildings when every builder was keenly interested and imbued with a knowledge and love of his art. We need variety and power of self-expression in our work; to be too mechanical is to deaden our souls. I am saying this because I see a certain danger in the great development of machine and other repetition work which is now with us and which must increase vastly in the near future. I don't wish to discourage the machine work, for I believe it is of enormous value and that every foundry must use it to its full extent. We cannot stop machine invention, and we do not want to. Cheapness of production is not only forced on us by competition, but is in itself a general advantage so long as the quality of the castings is maintained and improved. But work on the same job week after week and month after month is deadly dull, and may let the mind weaken for lack of exercise. Businesses which recognise this, which know that they need live men in their employment, men alive in mind as well as body, keen in their work and quick to see and suggest improvements of machines or methods—such businesses will deserve and secure success. It's not easy to see the way out of difficulties at once, but if we think over them different solutions will occur to us and one will help another. Some variety in the work to be done is essential; moving from one machine to another or from one process to another. Some understanding of the scientific facts lying at the back of and explaining processes and results adds enormously to interest in work. Here our Association can and does give great help. Above all things I think we want to be sure that when boys are being trained in a foundry they do not get fixed too long on repetition work. They should have a thorough training in as many of all the foundry processes as the organisation of the works will permit, and the organisation should be such that a wide training can be given. The better training we give to the apprentices the less grumbling we shall hear about the scarcity of first-rate moulders.

As I said last year, I believe that the foundry industry is full of interest, an interest which reacts on the men engaged and makes them good workers, good citizens and good companions. But there are corners of the trade where there are dangers of this interest dying out. Like other trades, we pass through the usual stages of evolution and reach the stage of machine work. I am hoping that we may learn wisdom from noting the drawbacks that have shown themselves elsewhere, that we may make full legitimate use of machines and at the same time lessen so far as may be the disadvantages that may arise for those who work them.

This human problem must be kept before us, for on that depends the future prosperity of our industry, at least as much as on the many other practical and scientific problems which we delight to discuss. (Applause.)

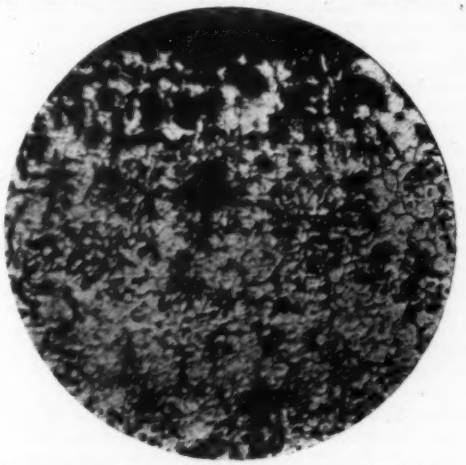
MR. F. J. COOK, in proposing a vote of thanks to the President, expressed his great appreciation of the very sympathetic way in which Mr. Gimson had dealt with the manual side of the work, which must appeal to everyone. They felt strongly the care that was necessary not only for the young members of the trade, but in the interests of all employed in foundry work.

MR. R. BUCHANAN, in seconding, said the President had done well in keeping before them the necessity of avoiding the deadening effect of interminable repetition work. It was not only incumbent on managers and foremen to ensure it, but was also in the highest interests of employers, that the boys especially should have their faculties developed to the fullest degree, because on their power and ability to take the places of the present generation would depend the future of the industry. (Applause.)

ANNEALED CASTINGS FOR TEXTILE-MACHINE SPINDLES.

A Paper on this subject was then read by Mr. R. Buchanan (see page 368), who invited the members to examine a number of samples he exhibited.

Mr. H. P. Mason (Oldham) said that in regard to the hard skin on castings, he felt confident that the slide exhibited by the lecturer did not show cementite, as Mr. Buchanan apparently believed. It was very important to have a true conception of what really occurred, and he did not think that in the present case the choice of picric acid as the etching reagent had been a wise one. He had no doubt that the sulphur dioxide existing in the furnace gases was altogether responsible for the hard skin. This gas interacting with hot iron formed a mixture of sulphide and oxide of iron, and as shown on the photomicrograph of skinned metal (which had a magnification of 100 diameters and had been etched with a 4 per cent. solution of nitric acid in amylalcohol) the contact of the furnace gases with the metal had resulted in an interpenetration of oxide and sulphide of iron along the lines of the graphite. The hard skin occupied about three-fourths of the diameter of the photograph and the grains of ferrite (which were resolved better with nitric acid etching than



Photomicrograph illustrating Mr. Mason's Remarks.

when picric was used) could be seen with the sulphide of iron existing amongst them in the areas originally filled with graphite. A Baumann auto-sulphur print gave absolute proof of the presence of sulphur. He thought that Mr. Buchanan was wrong in his cementite theory, but he agreed with him that sulphur in the furnace was at the root of the whole trouble. If the furnace gases were kept away from the metal by suitable packing material, there would be an end of the matter.

Mr. F. J. Cook said his interest arose chiefly from the fact that he sometimes used annealed iron for castings, and he had been somewhat in the dark as to some of the results obtained. He had nothing to do with small castings as a rule, but a few he had made were less than 3/16 in. thick, and occasionally these were found to be hard on the corner. They were annealed by being put into a gas-coke fire. He had had one case in which they had been hardened, though they had generally been softened; and since gas coke was known to be very high in sulphur, it appeared from the Paper that they ought to have been hardened, seeing that they were annealed in direct contact with sulphury material. If Mr. Buchanan could give him any suggestion on that point it would be helpful. He would especially value any information that Mr. Buchanan could give him as to the annealing of large castings, such as liners and heads for large gas engines. Those castings weighed up to 15 cwt., and could not be conveniently put into cans. They had once or twice found that those castings, instead of being softened, had been considerably hardened. They had been put into the furnace, and had been soaked for some time, but in two cases they had come out of the furnace harder than they were put in. The castings were open to the flame, and it was just possible that might be the cause. He would especially like to know what suggestions could be made with regard to this class of castings which could not be put into cans.

Mr. H. Jewson (Dereham) raised the question of whether the soaking of the casting was really necessary for annealing. He would like to know whether Mr. Buchanan thought that if a casting was heated up above the critical temperature and then allowed to cool fairly quickly, the same result would not be secured as by soaking.

Mr. J. Hawkins (Sheffield) enquired whether Mr. Buchanan had had any experience of the effect of re-annealing in the treatment of castings that had been hardened on the skin.

Mr. R. Buchanan, replying, said he was much obliged to Mr. Mason for his remarks. Some years ago he had discussed that matter with him and they would find if they looked at his Paper again that he had not committed himself to the cementite theory, although it might perhaps be that he had done so in his remarks. Really, he was not quite sure on the matter, and he had already told them so, but he felt sure that Mr. Mason was correct in what he said; as they were agreed on the more important matters he did not feel that that was a very material point. The main fact, and with that Mr. Mason agreed, was that sulphur was the cause of the trouble. The next thing to consider was the means to be adopted to prevent the sulphur from causing the trouble, and having agreed upon that to induce their friends to act on that information. He was hopeful that the Paper and the discussion would prove helpful to those friends engaged in that particular business. He was greatly obliged to Mr. Mason for the trouble he had taken, because he (Mr. Buchanan) had him in mind when he tackled the Paper. With regard to the annealing of large castings, he had very little doubt that sulphurous flames, the result of having to burn coal or coke, caused the hardness. There was certainly a great deal of sulphur in those flames. That in itself indicated the direction in which a cure was to be sought. If perfect annealing was required, a "close" oven would be necessary where the heat was conducted through walls, so that the casting was not brought into direct contact with the flame; but that, of course, meant a bigger expenditure on fuel. With regard to Mr. Jewson's query on the necessity of soaking, he did not think it was feasible to accomplish the object by heating the casting just beyond the critical temperature and allowing it to cool. There was nothing miraculous about that heating business, and they had to give it time to do its work in changing the carbon. Of course, the higher the temperature above that point, the more free carbon would come out. That would, naturally, involve a risk of warning the casting. The carbon could be got out to the greatest extent by the maintenance of the heat over as long a time as was commercially

possible, and by that means the softest result in the annealing of the casting would be got; but he did not much believe in attaining a high temperature and then falling away from it. There was nothing like allowing time to accomplish the work. Mr. Hawkins had asked a question about re-annealing. Personally, he had only once come across a case where a hard skin had been changed by re-annealing, and in that case the skin was very thin. The re-annealing was effected by packing the casting in new borings, which apparently took back some of the sulphur which caused the trouble, and so the castings were able to be used. But in the hematite casting of which he had spoken he annealed that several times; he tried annealing in fresh coke, in lime, and in charcoal, but the hard skin remained, although it should be said that in that case the skin was a very thick one. He considered that if the skin was thick the chance of saving the castings by re-annealing was very slight, and the best plan was to melt them up a little at a time, spreading the melting over as long a period as possible, so as not to poison the metal with which they were melted.

CORES, WITH SPECIAL REFERENCE TO THE USE OF SILICA SAND.

Mr. F. C. Pulsford (Leicester) followed with a Paper on this subject (see page 371).

The author, replying to a question by Mr. Carrick as to the proportions of oil and sand, said that the proportions depended upon the character of the oil and sand; but the sample cores shown had been made up with one portion of Beeston sand, two portions of returned sand, and one portion of Bedford sand; the latter was of finer grain than the Beeston sand, and the effect of that was that it came away afterwards much more smoothly. The returned sand, of which there were two portions, consisted of the residue of the Beeston and Bedford sands, that was to say, they had used over again the old cores. The oil he had used was cold-drawn cod oil, the price of which at present was 19s. or 20s. per cwt., though the price varied. With regard to the amount used, one had to be guided by experience, using just enough to give a proper bond to the core. What he meant by that was that the sand, being silica sand, could not absorb oil. Sufficient was that amount which covered each particle or grain of sand. It was a question of the particles of the sand having sufficient on their exterior surfaces to rub against each other, so that when it was rammed and baked there was naturally a bond between them. The mixture depended entirely upon the nature of the work to be done. It would be quite obvious that a long fragile core would require more bond than a shorter one, and he thought only experience could guide one to just the right quantity. A certain amount of water could often be used with the oil, but that depended on the job in hand. For a strong-section core probably 20 per cent. of the oil could be saved, but the cores he had exhibited were of small and fragile section requiring a fair bond. They were very fragile, and if they were so made that they would just hold together they were much more readily dealt with afterwards.

A Member said that Mr. Pulsford had given a Paper which, it would be admitted, was limited in its scope; but since he had given facts from his personal experience, that ought to be acknowledged. At the same time, he (the speaker) appreciated the request for more definite information in regard to the mixtures. Probably experienced workers making experiments with core oils would have a general idea as to the lines upon which they should experiment to get satisfactory results. But taking each oil individually, there were general rules which could be given in regard to the proportions to be used with different sands and different classes of cores. One of the limitations of the Paper was that the author confined himself practically to one oil; whereas there were something like a dozen oils that were being used with very satisfactory results, and also other compounds which it was not necessary to specify, but which gave quite as good results. It was not necessary to use a sharp sea sand or a pure silica sand with some of these; any tolerably clean sand that had not an excess of clay in it could be treated in the same way. But no doubt the author had selected what he considered to be the best material for his own work and condition. He (the speaker) would like to know whether the author had ever experimented to determine whether extra kneading or mixing would allow of a material reduction in the quantity of oil used. It had been found possible in some cases to reduce the amount of oil required to the extent of 75 per cent. by proper mixing, *i.e.*, by carefully incorporating the oil among the sand particles. He quite agreed with Mr. Pulsford that though the centrifugal mixer was an admirable machine for certain classes of work, for other classes it was useless, and something more was required—something in the nature of a mill that would not crush the particles, but which would give the same kneading effect and incorporate the bond equally among the particles by rubbing them against each other. A simple experiment would illustrate what was necessary. If a little sand were worked up with a little oil in the palm of the hand, a much stronger and tougher composition would be obtained than would be produced by any existing machine using the same proportions of material. There was also a point he would mention, viz., in regard to green-sand cores. Mr. Pulsford had either said too little or too much on that subject. He had merely whetted their appetites in regard to green-sand work, but had told them really nothing about it. Green-sand core work was not nearly so generally applied as its possibilities warranted, and further information on the subject would therefore be very acceptable.

Mr. F. J. Cook (Birmingham) said he quite agreed with the previous speaker that working with oil-sand was by no means so novel a matter as some people might suppose. What was wanted at the present time was information of a definite nature, as the system had been practised by many people for a long time past. One of the points mentioned in the Paper was the emulsifying of oil and water. That statement emphasised the value of technical societies like theirs, in rubbing off the personal little vanities that most people possessed. Until he received the Paper he (Mr. Cook) was proud enough to think that he was the inventor of the use of a mixture of oil and water in England for the making of cores, but he found he was mistaken. It was true, however, that he had done a lot of work in connection with that class of cores. The work he had to do with was not generally of the repetition type, of the class which the speaker had been describing to the meeting; but he had found it necessary to use oil-sand for special cores in such castings as water-jacketed cylinders, and the use of such cores had been of great assistance. With regard to emulsifying, of course, there was a difficulty when mixing oil and water in getting it homogeneous, but he had succeeded very well with it. First he tried compressed air for emulsifying, and that was partially successful, but he had now invented a little machine which

enabled him in five minutes to mix the oil with the water, and there was no danger of failure. It was very important to get a proper proportion of oil and sand, and it was possible by careful measurement and experience to materially reduce the cost of making the cores. Personally, he had tried many mixtures, but the one he found most successful was a mixture of one part oil to six of water, *i.e.*, one in seven, and this was quite a good proportion for large cores running up to 2 cwt. He would like to know Mr. Pulsford's ideas in regard to emulsifying, and how he carried it out. For large castings, he had used one part of spermolin emulsified with water to forty-two of sand. If Mr. Pulsford would state the proportions used, he would be able to judge which of them was doing the better. The castings he was referring to were cylinders weighing up to two tons, with a thickness of 1½ in. to 2¼ in. of metal.

Mr. R. Buchanan (Birmingham) said that he understood that in the manufacture of washable distempers for decoration work, oil and water were mixed by means of skimmed milk, utilising the caseine contained in the milk to mix the oil with the water. He understood that worked very well, so if they could not get the emulsifying machine mentioned they might try that experiment. (Laughter.)

Mr. R. Carrick (Shipley) said he thought they were all under an obligation to Mr. Pulsford for introducing the subject. He had, however, dealt with it as if it was an entirely new thing and quite unknown in this country. As a matter of fact it was very extensively used in this country, and especially in the North. He himself had written an article for the Foundry Trade Journal on this subject some four or five years ago, and had then given about a dozen different oil-sand mixtures, the ratio of oil to silica sand in each case being about one to forty. There was no secrecy about the matter in his district. He also mentioned that splitting cores for heavy flywheels were commonly used. Personally, he had used oil-sand cores in America fifteen years ago, and was working in one of the largest shops out there when the Moseley Commission paid a visit from England, and Mr. Maddison, who represented the moulders, told him that one of the things that struck him most in visiting the American foundries was the extensive use of oil-sand cores. There was no doubt as to oil-sand cores being far better for intricate work than cores made with loam sand.

Mr. J. R. Hyde (Sheffield) quite agreed that oil-sand cores were certainly not new, and he thought that most of them had had some experience with oil-sand in rotary core machines. He had, however, to give other people credit for going ahead much more rapidly in the use of oil-sand. At Sheffield they had a Paper by a gentleman from Halifax, who proved to them that there was a great advantage in the use of such mixtures as those described by Mr. Pulsford. But although that Paper was tremendously appreciated, he did not think that there was much more oil-sand used in the foundries than before the Paper was read. They were all convinced of its advantages; but for some reason did not go ahead and use it. Personally, he had tried the use of oil-sand, employing linseed oil and also some others. But he found a certain difficulty in getting the cores to leave the boxes. One or two could be made all right, but when they began to be made continuously, there was difficulty in persuading them to keep their shape. If the author could give him some hints as to how to do that, and also to retain the smooth skin which was so very important, he would be glad.

Mr. F. Penlington (Manchester) asked whether Mr. Pulsford had obtained any statement as to the relative costs as between the use of ordinary sand and oil-sand. He would like to know the total amount saved as between the two classes of cores. He would ask also how many men would be required to mix the sand by hand or in any other way, or whether he would admit the use of a machine. What was the cost of the cores per ton of castings by the use of oil-sand, and what was the difference between the present cost and the cost prior to its introduction.

Mr. W. H. Freeman (Gainsborough) asked what the author meant by the statement that "with oil-sand cores no patching nor external venting is necessary?" He did not quite understand that remark in the Paper.

Mr. F. C. Pulsford, replying to the discussion, said that in regard to the mixing of the materials, the great necessity was to mix by rubbing the particles of sand together. It did not matter whether that was done by a shovel or by a machine. If they could get a machine that would do equivalent work to a shovel, they might work still more economically and satisfactorily. If they could turn the particles over, simply disturbing them, it was better than whipping the mixture round with a centrifugal machine. Milling also was quite useless, because it broke up the sand particles, which were required to be retained whole as much as possible. It was really a question of rubbing to get every little grain of sand surrounded by a particle of emulsified oil. As to green-sand cores, he had only introduced the green-sand question, because he thought ironfounders in Leicester knew very little about or neglected to apply some of the refinements of iron founding. The introduction of green-sand cores came at least 40 years ago, and it had been scarcely used in Leicester. At Derby or Sheffield it would be found that green-sand work was really very old. Mr. Cook had spoken of his machine for emulsifying oil. There were several ways of managing that. It could be done with a jet of steam if blown vigorously enough. With regard to the mixtures, he was unable to say exactly what proportion of oil he had got down to. He did not know at the moment, but the amount had been down to 50 to 1 for radiator cores. Mr. Carrick had referred to his own experience in the United States twelve or fourteen years ago. Personally, he (Mr. Pulsford) looked upon the United States as the home of the oil-sand business. They did the work without trouble, because they had made it their business. On this side of the Atlantic the advantages of oil sand were not half appreciated. His own firm were now fettling hundreds of those castings daily. About twelve years ago a man used to fettle about twenty a day, and now he was able to do about 140. He would start about seven in the morning, and was finished by about twelve. Mr. Hyde had referred to the fact that the production of oil-sand cores was not new. While that was quite true, that was not all the point of the Paper. What he wanted to urge was the more general use of the method. He did not know how old it was in the States; but it must be a very, very old practice. What he wanted to particularly urge was that it was not being used largely enough. As to getting the cores out of the boxes, at his own place they had two methods; one was the use of paraffin. If the core boxes were not kept clean the sand had a great tendency to adhere to the walls, but if they were kept clean by brushing with paraffin every night they would be right for work in the morning. Another method of freeing the cores from the boxes was by the use of dry sand, particularly for wooden boxes. Some of the cores exhibited were

made in ordinary wood boxes, then built up. The print was run through into a block which could not be rammed out. Finally the core was fastened. There was nothing special about it, as no special preparation was required. Generally, with an iron or a metal box paraffin would keep it clean. With regard to relative costs, he had no details or data to present to the meeting, but there were certain plain facts which might be stated. Some years ago they used to pay 7½d. for a core; but they reduced that by more than 100 per cent. in wages, and one man was now able to make 140 a day. From the point of view of economy, there was no question about it, and he felt that he was on perfectly sure ground in recommending the system, although he could not give them actual cost figures. Mr. Freeman wanted to know what was meant by "no patching." Well, his firm made some cores in loam sand for vapour chambers for gas producers. He was often astonished to see the amount of patching that was done on those cores. It was, on the other hand, almost impossible to patch oil-sand cores, and so a man could not fool them so readily. It paid him better to knock the job out and start afresh, as one would do with machine-made moulds. Personally, he preferred to see a man knock out a spoiled core, unless it was a very big job, rather than put a lot of repair work on it. In small work it was better to destroy it, because no amount of patching would give as good a job as if the sand left the core box properly.

The meeting adjourned until the next morning.

Mayoral Reception.

A very successful reception was held on Tuesday evening by the Mayor and Mayoress of Leicester (Councillor and Mrs. J. Russell Frears), when the members of the Association and their ladies were entertained at the Mayor's Rooms. A number of invitations had been issued to leading Councillors, engineers and representative townspeople, Mr. E. H. Goodchild (President of the Leicester Association of Engineers) and Mr. W. Keay (Vice-President) being among the guests. The visitors were formally received by the Mayor and Mayoress and Councillor and Mrs. Gimson.

Following the reception there were short speeches. The Mayor said he desired, on behalf of himself and the people of Leicester, to give the British Foundrymen's Association a hearty welcome. He understood that was the eleventh annual Conference, and whereas at the first Conference there were ninety-eight members, there were now about ten times that number. That showed that the Association was serving a useful purpose and appealing to the members of their trade. He congratulated them on the fact that unlike the Federations which existed to keep up prices and enlarge profits, they sought to advance the industry on the scientific side. They were also able to lay aside the petty jealousies so prevalent in many industries, and instead of making a great secret of their processes they consulted together for the common good. He thought if they in Leicester took a leaf out of their book they would be much better for the visit of the Association. The speaker, recalling his own early days, said he once studied for the profession of a civil engineer, and during five years at Hull with the dock company he did a great deal of mechanical drawing. He made many fine drawings and designs, beautifully finished, most artistically arranged, but when they got into the hands of the foremen they declared in very plain and outspoken language that they would not work. (Laughter.) He then learned that to be a successful draughtsman a close acquaintance with workshop practice was necessary. The Association was to be heartily congratulated on the presidency of Mr. Gimson, for the name of Gimson was regarded with pride in Leicester and was connected with everything they thought of when they spoke of good citizenship. (Applause.)

Mr. S. A. Gimson, on behalf of the Association, thanked the Mayor for the splendid reception he had accorded them and for his kind words. He (the speaker) claimed that their industry was an aristocrat among industries, going back to the time when people never thought about boots and shoes and did not trouble much about hosiery. They employed the founder's arts, however, in the manufacture of bronze implements, for which they had many uses, for example, in the course of their little arguments. Nowadays, foundrymen, when they had a good cast met in a friendly manner and did not use the results of their castings in the same way. (Laughter.)

Mr. R. Buchanan also added his thanks.

An excellent programme of music by the Victoria Band, in the main hall, and the Blue Wyvern Band, in the Art Gallery, where refreshments were served, enlivened the evening. In addition there was an exhibition of photographs, chiefly of Old Leicester, provided by the Leicester and Leicestershire Photographic Society, and a collection of microscopic objects.

Wednesday's Proceedings.

The meetings of the Association were resumed in the Technical School on Wednesday morning, May 13.

The President announced the receipt of letters of apology from Dr. W. H. Hatfield (Sheffield), Mr. R. W. Kenyon, and also from Dr. Percy Longmuir, who was joint author of a Paper to be presented. Dr. Longmuir forwarded a Note on "Foundry Yields," by Mr. Robinson and himself, which he desired the Secretary to read if it should meet with the President's approval. The authors would reply to the discussion later. The object of the note was to place on record ascertained figures for one class of work, and if possible to induce publication of figures for other classes of work.

The President announced that Mr. Cook would read the Paper sent by Mr. Longmuir, and the discussion would be taken in the ordinary way, and then the replies of the authors would be printed later in the Foundry Trade Journal and in the "Proceedings."

DESIGN AND WORKING OF THE FOUNDRY CUPOLA.

Mr. E. L. Rhead, M.Sc., read a Paper entitled "Some Considerations in the Design and Working of the Foundry Cupola" (see page 373).

Mr. R. T. Rolfe (Bedford) said that Mr. Rhead was properly insistent on the fact that the volume of air admitted through the tuyeres was more important than its pressure; that no matter what pressure was obtained poor results would be got in practical work if the volume of air admitted was insufficient. The author had given a set of very interesting tables, showing the ratio of tuyere area to sectional area of cupola at the tuyeres, by which tables he showed that a ratio of 1 to 17.4 and 1 to 20 were arrived at, which the author mentioned compared very well with another authority, Bellamy, who gave 1 to 19.2. He (the speaker) would like if possible to know how this figure was arrived at, because it did not seem to agree with the usual figure quoted. According to Keep, the tuyere area should be not less than 1/9th of the sectional area

of the cupola, and he believed that McWilliam and Longmuir gave the proportion as 1/10th for small cupolas and 1/7th for large cupolas—that was the ratio of the tuyere area to the cross section of the cupola at the tuyere points. The authorities seemed to be at issue on the matter, and he would like a little further explanation upon the point. As to the amount of air admitted to the cupola, that was a very important point. In the cupola there was a layer of red-hot coke through which the air from the tuyeres passed upwards. When the air entered the cupola at the bottom, carbon dioxide was largely produced, owing to the air being in excess at the tuyeres. A little higher up, the dioxide was largely reduced to monoxide through passing through the layer of red-hot coke. If all the free oxygen had already been burnt up, there would be none left for the carbon monoxide to recombine with when it had passed through the layer of red-hot coke. It was obviously necessary to investigate the gases to see whether there was any free oxygen left, because it seemed quite possible that free oxygen might pass up through the red-hot coke, some of it not being entirely used up. The author said:—"Obviously all air that enters the cupola at any point must be actually burnt." If that was so, there must be a great loss of potential heat, because the heat developed by the production of carbon monoxide was only one-third of that which was developed by the formation of carbon dioxide. The matter required further investigation.

Mr. M. E. Gallon (Dunston-on-Tyne) said the author had stated that if there was sufficient blast put into a cupola, after carbon monoxide was formed, carbon dioxide could be formed with the remaining free oxygen. He had read in Sir Lowthian Bell's book on "The Manufacture of Iron and Steel" that carbon dioxide could *not* be formed with free oxygen; whatever oxygen the carbon monoxide took to itself to form carbon dioxide must be taken from the stock, *i.e.*, the material put into the furnace. If that was so, then there was little opportunity of getting carbon dioxide from free oxygen blown into the cupola. Therefore, there was very little left to do, except, when putting such material into the cupola, to see that it contained as much oxygen as they could get, consistent with obtaining good metal. Then Sir Lowthian Bell said they could not get carbon dioxide properly formed in the furnace, and he understood that one unit of carbon turned into carbon monoxide produced 2,400 units of heat, and that if the same unit of carbon was converted into carbon dioxide it developed a further amount of heat to the extent of 5,600 units, making a total of 8,000 units of heat. He gathered from the same author that in practice it was impossible to do that, and the most they could get out of carbon in the dioxide form was one-third that amount of heat. Therefore, that explained to a very great degree why they used so much more coke than they ought to do, according to the scientific formula. With regard to the type of cupola, that largely depended upon their pocket. If they had plenty of money they could secure plenty of good cupolas; but if they had very little money they perhaps had to start building a cupola out of an old boiler, or something of that sort. With regard to the remarks on blast pressure, he had heard one of their members say that if they put the blast into the cupola in the "soft" form—that was to say in the form of a zephyr instead of a whirlwind—they would get soft metal; but he rather gathered from the author that they could not get soft metal from soft blast. He would like some further information on that. The author also dealt with the narrowing of the furnace, and said the melting zone must be in the narrow part. It appeared to him that there was no benefit to be gained from the widening of the cupola if the melting zone had to be in the narrow part. Apparently, the author did not think that much was gained by the tapering of the cupola. In large cupolas, he thought, it was very good practice to have a straight shaft, but he believed that the small Voisin cupolas were tapered with the narrowest part at the charging door. That, apparently, was a very good thing to stop the cupola from hanging. He had a small cupola of that sort at his works in the North of England, and it worked very well. The question of the tuyeres was, of course, a great one, and he believed different men could get different results from the same sort of tuyeres; but it really depended on how much blast was at command. A man who had only just sufficient for the metal he had to deal with every day had very little scope. He (the speaker) worked 20 years ago with a ramshackle cupola which was still in operation, working with two tuyeres, one on each side or opposite each other, and each 6 in. in diameter. The blast was delivered from a small fan, and it was possible to get out 25 cwt. of metal an hour. Then they managed to raise it up to 27 cwt., but when more metal was required a bigger blower was installed and with the same tuyeres they were later able to get from 30 to 35 cwt. per hour. This, however, was not satisfactory with a two-ton blower, so two tuyere boxes were cast with two tuyere holes in each box. These were built into the lining of the cupola, and the improvement had been very great. Out of a 27-in. cupola, the same old cupola with outside arrangement the same, they now got 2 tons 5 cwt. per hour, and it had melted at the rate of three tons per hour.

Mr. F. J. Cook (Birmingham) said the height of the cupola undoubtedly affected economy, inasmuch as a reasonable height above the tuyeres gave an opportunity to absorb the heat. He was in agreement with the lecturer with regard to the straight-shaft cupola. He considered that was quite sufficient for all practical purposes, and he had no hesitation in saying that it gave as good results as any other form. It was most economical in use, it required less fettling, and it was possible to work the same cupola every day, which was a very important point. The tuyeres also were very important; but he had dealt pretty fully with that subject at the previous Conference. A good many tuyere designs were not based upon real scientific ideas, and many users built their cupolas different from other people without any real scientific reason. Nor were they put in as the result of experience. It was very common to see many cupolas with the tuyeres enlarged towards the centre of the cupola. He thought that was wrong. Velocity of the blast was important, and was, he believed, first mentioned by himself last year. A penetrative action of the blast was necessary to supply air to the seat of the work to be done. Sufficient velocity to penetrate the cupola was necessary to get the best results. Without that velocity the blast would follow the line of least resistance, and escape without doing its work. That point was not dealt with in the Paper, but it was of very great importance. Another question dealt with related to the two rows of tuyeres. He was quite in agreement with the author that there was very little advantage to be obtained from two or more rows. It was really a question of getting through the tuyeres a sufficient volume and velocity of air. The only

effect of putting in double rows was to raise the height of the melting zone, which was unnecessary. That naturally involved the question of tuyere area, which required to be in accordance with the work to be done. A different tuyere area was required for hard metals to that required for soft metals, and it was not good practice to have the same area for both descriptions. The area should be varied according to the class of metal melted, and one style of tuyere would certainly not suit all classes of metal. The question had been raised as to reducing the area of the bosh below the melting zone. The only thing to be obtained by that was an economy of coke through reducing the amount required in the bed, but the best coke economy could be got by having a reservoir. Mr. Gallon had raised the question of the size of the blower and its relation to the size of the cupola. The best blower for the work was an electrically-driven variable-speed blower with which the speed could be varied according to judgment. To instal a one-speed blower was a great mistake, for if there were no means of increasing the blast there would be difficulty experienced.

Mr. F. C. Barker (London) said the author had given an instance of the working of the straight cupola, but he (the speaker) had noticed in some cupolas that after the blowing was finished the bosh was larger. He would like to know whether the charge had anything to do with that. He knew a certain cupola where the tuyere was put in at a different angle so that the burning was below the tuyere instead of above it. He wondered whether the charge affected that. A tilting brass furnace would always have a bosh formed at the bottom more or less according to how the man charged the coke. If he rammed down the coke close together so as to stop the air from passing through the coke freely there would always be a bosh formed larger than if properly placed around the crucible.

Mr. R. Buchanan (Birmingham) said that, with reference to the belief that castings soften as the blast pressure rises, his experience had led him to an opposite conclusion. He did not think it was wise for any man to pin his faith to what any other man had said if he did not find that true in his own experience. He had met with a man who was going seriously wrong with his cupola by reason of following a statement of his (the speaker's) to the effect that the best foundryman was the man who used the least coke. That was clearly a misunderstanding, for he never meant to convey that the man was to use too little coke. He (the speaker) had been in the habit of using cupolas that were narrowed in, and he practically never had any trouble with the hanging up of the charges just where the narrowing ceased. The principal objection he had to it was the difficulty of keeping the form with that narrow shape. It had always been a difficult point with him to decide whether the result was worth the effort, and he had a slight inclination to think it was not. He would like to ask Mr. Rhead to give his ideas as to what caused the wear in the melting zone. The point was, did the wear take place from the actual contact of the solid fuel at that point, or was it the flame effect from the coke at the lower level?

Mr. E. N. Wright (Wolverhampton) said he was particularly interested in the Paper because he had been recently constructing a cupola on his own account. He did not agree that the cupola, or its construction, depended upon the depth of one's pockets. He had a very efficient one made out of an old boiler shell. He bought an old boiler for the purpose, and the cupola was working very well indeed. He would like to acknowledge his indebtedness to Mr. Cook for his excellent guidance in making that cupola. No doubt Mr. Buchanan was right in saying that they should not take any man's word purely and simply, but should rely on their own experience. But he did not see what else a young man, without a great deal of experience in making cupolas, could do. He had followed Mr. Cook's guidance, but generally he must admit, before he did anything that Mr. Cook said he made sure that it agreed with his own reason. (Laughter.) With regard to the tuyere area, the ratio to cupola area in his own cupola was 1 to 7. The work was general jobbing work, and at that ratio it worked very well.

Mr. J. Smith (South Shields) said that the more he studied the question of cupolas, the more he was convinced that practically no progress was being made. If they were to get from the experience of the speakers particulars as to the design of the cupolas and the results obtained, they would begin to get to know the direction in which they were moving. About five years ago he had built a furnace on a design that had existed for over a hundred years, and he could honestly say that up to now he had not found anything better. That cupola was melting at the rate of eight tons an hour, with a blast pressure of twelve ounces, and the work being done was high-class. The results from that cupola were absolutely good. That cupola did not cost him more than £60, while certain more modern ones which were far less satisfactory had cost other firms over £270 each.

Mr. E. L. Rhead, replying to the discussion, said two or three speakers had referred to the tuyere area, and the ratios given in the Paper. It was not the intention to make those applicable in all cases; they were only figures which had been got out in a particular case in dealing with some heavy castings. The iron was a fairly hard one of great strength. No comparative references were made with regard to those tuyere areas, and they were considerably less than was advisable in most cases. Mr. Gallon had raised some questions which he (the speaker) unfortunately could not get down, so perhaps Mr. Gallon would submit them in writing. Mr. Gallon had spoken of Sir Lowthian Bell's reference to carbon dioxide only being produced by oxygen taken from the stock. Probably many there would be aware that Sir Lowthian Bell was not dealing with the foundry cupola when he wrote that; he was discussing the iron-smelting blast furnace, and the oxygen was taken from the iron ore in the course of its reduction. There was no reference whatever in that to anything which happened in the cupola. To introduce oxygen by means of the stock in the cupola would be a very expensive policy; in fact, it would destroy the quality of the iron and prevent the production of good material. That practice would remove the valuable metalloids, silicon and carbon, so necessary to the constitution of the iron. The question of whether or not iron was made harder in the cupola furnace was not a question of blast pressure at all; it was a question of the constituents of the iron, a question of the silicon or any softening constituent, and particularly whether that constituent was removed or not in the course of the passing of the metal through the furnace, and whether the iron was melted at a sufficiently high temperature to take up or retain the carbon present in it when it was introduced into the cupola. If there was an excess of blast used and that came into contact with the metal at any time after it had been melted, or in the act of melting, the removal of the silicon was certain to take place to a greater or less extent, and the iron would be rendered harder. It would be quite immaterial whether the blast was at high pressure or at low pressure; but the probabilities were that if the blast were at high pressure it would be concentrated at the tuyeres, a large quantity of

air would enter the furnace in that region, and there would be a greater chance of the melting metal being exposed to an excess of air as it dropped from the melting zone into the bottom of the furnace in front of the tuyeres. With regard to the blast pressure, he thought that matter must be taken into account only so far as the blast pressure increased the quantity of air in the melting region and in the neighbourhood of the tuyere; and that excess of air, acting upon the metal, might produce hardness in the casting. He would like to have Mr. Cook's ideas on these points. Observers differed with regard to bulging sides and to a contraction in a cupola. In cupolas contracted in the lower part the blast frequently passing up at the side of the cupola chilled some of the melting or actually molten material upon the ridge which extended round the body of the cupola, and so the material started cooling, and once that was started the trouble commenced, because that ridge diverted the direction of the blast, and the blast left behind it a place that was not affected and that did not get heated to the same extent. That stopped the heat and prevented it getting through the ridge, and so formed growths on the side of the furnace which prevented the gases carrying the heat going through, and anything that was cooled solidified there, and thus bridging was the result. A question was raised by Mr. Gallon with regard to the contraction of the lower part of small cupolas. If there was any gain at all in the contraction of the cupola, it was in the larger cupolas, and this arose from the fact that it might give some support for the stock, as well as secure the concentration of the blast in the furnace. Mr. Cook had referred to the necessity of having a certain velocity in order to carry the blast into the furnace. Somewhere in the Paper he had called attention to the fact that there was a certain air velocity and pressure of blast for a tuyere area that was necessary to carry the blast well into the charge, and that unless the blast was uniformly distributed over the whole section of the cupola the best results could not be got. He had also pointed out that the best results were obtained with a certain velocity to ensure satisfactory contacts of the gases with the stock in passing through the furnace. Mr. Barker had raised the question of the tuyere being set at an angle in the cupola and burning out the lining below the tuyere. That was due undoubtedly to the concentration of the heat on the lower plane. The burning out of the lining was due to the concentration of the heat at that point. In the crucible furnaces to which Mr. Barker referred, the burning out of the lining at the bottom was due to a similar cause. The absorption of heat by the cold air entering through the bars caused the highest temperature to be developed a little above the bars, so that the walls of the furnace suffered in consequence. The gases cooled to a considerable extent before they reached the upper part of the furnace, the result being that the upper part of the walls was not affected by the heat. Mr. Buchanan would recognise that in the melting zone there was the highest temperature, that the walls suffered from the heat radiated by the coke, and also that the ash produced would exert a fluxing influence on the furnace walls, besides which there was the gas friction, which was most troublesome at the highest temperature. Lastly, there was the possibility often realised of the breaking away of part of the material used for daubing, through its not having been properly put on and attached to the sides of the furnace.

Mr. Cook (Birmingham) said that Mr. Rhead had asked his opinion on the question of the hardening of the metals through blast pressure. He was quite aware of all the chemical actions that took place and which might be expected to give hardness, and those which Mr. Rhead had mentioned were quite correct. In the course of a long research which he undertook in regard to that work, and which lasted two or three years, he was surprised to find that the hardness changes in the material which he had referred to did not follow the chemical laws, and were not due to excessive oxidation. This appeared very remarkable to him when he expected to find that the hardness was due to the reduction of the silicon by oxidation. The chief work was done with iron which contained 1.25 per cent. of silicon with a total carbon of 3.2 to 3.4 per cent. Chemical analyses were taken, and though there was no appreciable reduction of silicon, the amount of carbon was reduced to the extent of about 0.2 per cent. on an average. Looking at that from a chemical point of view it was very remarkable, because the silicon ought to have been oxidised by much less blast pressure than would oxidise carbon. He did not believe that the carbon was actually oxidised, but that it was a question of mechanical action. At the temperature at which it changed into a liquid state the effect of the blast pressure was sufficient to remove some of the graphite. There was no doubt that at the point where the penetration of blast took place there was some loss of graphite. He did not believe there was an excessive oxidising effect, especially as there was not an excess of air, but it was just a mechanical action of the blast.

FOUNDRY YIELDS.

Mr. F. J. Cook (Birmingham), after reading the joint Paper by Dr. Longmuir and Mr. Robinson (see page 370), remarked that more was learned from one bad casting, if it was properly dissected and examined, than twenty good ones.

The President said that he remembered very well when he used to take figures of wasters—that was when he was in charge of the foundry of Gimson & Company. He could not remember the exact details, but for a period of something like ten years, the scrap, which used to include any casting which got into the machine shop and was sent back as being too hard, although there was nothing else wrong with it, varied generally from about 2½ to 3¾ per cent. He did not remember any year when it got up to four per cent., and the average over that ten years was something like 3 per cent. That was in a general foundry doing all sorts of work, running from cylinders to almost plain blocks of iron, and including many descriptions of small repetition work.

Mr. R. Buchanan (Birmingham) remarked that it was not clearly shown in regard to the weekly averages given whether the castings were produced for the firm's own department.

The President: Well, as to Gimson & Company, we were doing them about half for ourselves and half for the general public.

Mr. Buchanan said there was a very great difference between supplying one's own departments, and working for outside firms. There were some firms which had a large output from their own foundries and they were just as particular with the work which went to their own machine shops as with that which was supplied to other firms. But, speaking generally, a firm which owned an engineering shop and a foundry would sometimes pass for its own use castings which would be rejected by the outside buyer. Therefore, in writing out any averages such as those given in the Paper, it would seem to be very important to know for whom the work was produced. He had known some works where great advantage had been secured from the monetary point of view by getting out figures of that kind, but unless the point he had mentioned was explained the figures might be rather misleading.

Mr. J. R. Hyde (Sheffield) said there was one point about the totals given which was not particularly clear, namely, whether they started with the molten iron from the cupola. It should be remembered that there was always a certain amount of waste at that stage, and it was desirable to know how that was recorded, in other words where was the starting point of the figures? Was it the weight actually put into the cupola, or was it the weight when the runners and iron poured down had been deducted, because those runners had to be melted? In the one case there was a very big loophole for loss before the scientific data began to be taken into consideration.

Mr. W. Mayer (Dumbarton), Vice-President, said he had had a fair amount of experience in the making of ingot moulds, and the greatest difficulty he had found arose from the fact that they received their hematite for the purpose from the blast furnaces of a firm which made its own steel, and as all hematite iron was made with a view to being No. 1 metal, which meant having the right amount of silicon, sulphur and phosphorus, very often the iron which he got was such as could not be sold or be made into steel. The result was that he sometimes had moulds rejected on account of cracking with the first few heats, although the reason for that was that they were made of material which was not suitable for that class of work. The stuff, in fact, was sent to him to do the best he could with. A fact like that showed how misleading a tabulated average might be, because rejections might very well be credited to want of knowledge and experience or want of care on the part of the foundryman, whereas really the foundryman was in no way responsible for it.

Mr. F. J. Cook said that he would like to support and to emphasise the remarks made by Mr. Mayer. For engineering purposes he was not a lover of hematites, and for the same reason as that put forward by Mr. Mayer, namely, that foundrymen were very often supplied with hematites that other people could do nothing else with. Personally he had acted up to the suggestion of holding inquests on rejected castings, and if all foundrymen would take percentages, and keep definite figures, they would soon begin to become alive to what was really being done.

Mr. F. C. Barker (London) said that the percentages of waste were sometimes treated very unfairly. The most common thing was unfair rejection from the machine shop because of the alleged hardness of a casting. He had recently had four wheels rejected by the machine shop on the ground that the castings were too hard; but pressure was put upon the machinists who at first would not accept them, and a few extra hours were taken, and the wheels turned out altogether satisfactory. That clearly proved that some consideration should be shown by the management in the treatment of castings, and that with regard to calculations such as those given in the Paper, proper consideration should be given to the foundry. Naturally, such castings as those dealt with in the Paper would stand better than castings subjected to high pressure of air or water. One very great cause of difficulty in his own experience was the mistakes of the drawing office, where thicknesses were given which were quite unsuitable for certain castings.

Mr. Andrew Harley (Coventry) thought that too much emphasis could be given to the study of defective castings. He made a practice of devoting a considerable amount of attention to good castings and the means by which they were produced. After all, the study of the defective castings did not necessarily mean that a good one would be made next time. The study of good castings, however, involved keen observation and accurate knowledge of all the details by which the good result was arrived at. Then obviously the same direction should be followed and the successful method repeated in all its details. The personal factor entered into the production of castings more than it did, for instance, into the work of the machine shop; due allowance, therefore, ought to be made for that when bad castings were produced. Another great cause of defective castings in the foundry was unsuitable design. At the works where he was employed the foundry management took a very decided part in influencing the design of patterns. Five times out of six the alterations required did not affect the design, as such. It was also necessary for those responsible for design to work in harmony with the foundry and it was also very necessary that the foundry representative should be able to understand a drawing when he looked at it. It was no good criticising the draughtsman if they did not understand the drawing and were thus unable to point out the defects of the design even when given the opportunity.

Mr. R. T. Rolfe (Bedford) wished to know whether the tables given in the Paper represented the percentage of the number of defective castings, or that of the weight of the castings, because probably the castings were not always the same size. Then there was the question of the disposal of the scrap. How was the ordinary scrap, runners and risers, treated in the tables? It was not clear whether that was included or how.

The authors' reply, it was promised, would be communicated in writing.

THE PRODUCTION OF PLASTER OF PARIS PATTERNS.

This Paper was read in abstract by Mr. C. Heggie (see page 378).

Mr. Bert Sperring (Portsmouth) asked the author, with regard to the making of a pattern six feet long, whether he would suggest the pattern being joined together in short lengths and then fitted together in lengths of about one foot each? In that case would he suggest the use of chellac?

Mr. F. J. Cook (Birmingham) commented on the apparent benefits to be derived from plaster pattern work. He would like to know whether there was any disadvantage in the use of soft water as against hard water. Birmingham was supplied with soft Welsh water, which, for certain purposes, had to be artificially hardened.

Mr. G. M. Mather (Ashford) asked whether the results obtained by the author in the use of plaster were not largely due to the mixing of it by hand, so that the water absorbed some of the warmth of the hand, which had a tendency to harden the plaster. He had had some little experience of that sort of thing, and he had always adopted the practice of stirring with the hand, and the better results he got were due, he thought, to the warmth. Some moulders occasionally mixed with a stick, but he never found the results in that case quite so good.

Mr. W. H. Freeman (Gainsborough) said he believed there were various qualities and descriptions of plaster, and he would like to know what quality Mr. Heggie would recommend as the best for those patterns, and what solution he would suggest as the best to allow of the plaster mould being taken readily from the plate in which it had been fixed; also as to the methods he used in the preparation of patterns from which a number were to be moulded. It appeared to him (the speaker) that it would be necessary for plaster patterns to be faced with white metal, which would add considerably to the life of the pat-

tern. Had Mr. Heggie had any experience in this kind of work? If so, how did he secure the white metal to the plaster?

A MEMBER enquired whether Mr. Heggie had ever used white metal to protect the corners from chipping, as that had proved very useful. He (the speaker) had also found the use of jelly with oil an improvement as a mixture. He had also made extensive use of wood patterns, using the wood pattern for the first mould and then making the next mould with soft material with the use of white metal at the bottom of the mould, and pouring the plaster on the top. That had very effectively prevented the chipping of the corners.

MR. F. J. COOK (Birmingham) called attention to a new machine which had been got out for spraying metal on to a base of plaster work; it had been found possible to produce the most beautiful designs by spraying with metal, either tin, aluminium, or copper, and even gold. He had seen some very charming decorations and to a certain extent that had been introduced for engineering practice in the North of England. He had no doubt that a good deal would be heard of this in the future, especially for the making of finger plates for doors, and for similar decorative purposes. The metal deposit was of the thinnest possible description, but probably could be used to protect and strengthen the face of plaster-of-Paris patterns.

MR. D. DALRYMPLE (West Bromwich), referring to the illustration Fig. 5, said he considered that was a very good arrangement for large circular work. But he had never used the wheel arrangement on the template, and could not see where it would be of much advantage, because the inside of the template would still be resting on the board. He had had occasion to superintend the running in plaster of large furnace pans and steam-jacketed pans, and also the moulding boxes for those. They were done on a similar principle to that shown by Mr. Heggie in Fig. 5, with the exception of the wheel arrangement. An arm was fitted on to the centre shaft between the floor socket and the board, and the strickle on the template was fixed thereto in a similar way to that at the top. Of course, in that case, he did not use a wood board as shown by Mr. Heggie, but circular plates about three inches wide, and dovetailed into each other, so that they could be made up to any size required. Had he been working from a wood board, instead of using the wheel, he would have built a box on the top of the strickle, and put some 56-lb. weights on, so as to prevent the template from rising if the plaster happened to swell. One might naturally think that with weights up to two or three cwt. on to the template it would be difficult to push round; but if the board was true and well oiled, the strickle would go round much easier with the weights. He would like to emphasise what Mr. Heggie had said in reference to the saving of time and material by the use of plaster instead of wood. Even though the whole job had to be pared by hand there was still a saving.

MR. M. RIDDELL (Glasgow) said one point he expected would have been raised in the discussion was the very important question of the variation in size of the plaster pattern in setting. He would like Mr. Heggie to state what allowance was made for that and also if he found any advantage from the addition of lime. His experience was that lime had apparently eliminated shrinkage. Some time ago there was an almost similar lecture given before the Scottish Branch and he was somewhat surprised to find that very little was known about this method of making patterns in the engineering shops at Glasgow. His firm did not lay themselves out for jobbing work, but sometimes they did get little odd jobs to do, and whenever possible the pattern was made in plaster-of-Paris. Quite recently they were asked to make a spiral or worm screw of 4 in. diameter, 1½ in. pitch, with hollow shaft, to be used as a conveyer in some machinery. The conveyor was over 4 ft. long, and the pattern was run up in plaster in a great deal less time than would have been required if worked in wood. For mantel-pieces with mouldings and repeating ornaments such as Mr. Heggie had described, and which were sold in large quantities, the process was particularly suitable. The method generally adopted was to make up short sections of the moulding or ornament in plaster which were thereafter cast with tin composition. These pieces of tin compo. were then soldered together as desired, and a complete pattern so made. The working iron pattern was then cast from the tin pattern. The use of tin compo. was of great advantage when various sizes of the same design had to be made. In such cases it was necessary to make only the largest size first and after the iron pattern had been made to cut out from the tin so much as was needed to reduce the pattern to other required sizes. So far as he knew, engineering shops did not make use of this material, and he only mentioned it as a further step in connection with plaster work.

MR. J. SIMPKISS (Manchester) said he thought Mr. Heggie was to be congratulated on the revival of a rather old industry. The practice was very well known in the bedstead trade, and probably those members coming from Birmingham would know that the bedstead makers of that city made plaster moulds to be used as patterns to mould the ornamentation of bedsteads. To his own knowledge that had been done for the past thirty years at least. An article by Mr. Heggie had appeared in the FOUNDRY TRADE JOURNAL recently, which had given some Manchester patternmakers quite a fever for making such patterns for jobbing work, but he (the speaker) would like to point that there plaster patterns had somewhat curtailed the output and put a certain amount of increased expenditure on the jobbing founder. It was not every moulder who could handle a plaster pattern successfully; particularly careful men had to be selected for this work or the result was disastrous for the plaster pattern. Then again, in some cases when the question of the extra cost of that moulding was raised with their customers, they resented it very much, so that the onus of making that plaster pattern was put on the foundry, which was already a sufficiently ill-used department. It certainly was not new to work from plaster patterns, for when quite a boy he made many castings from such patterns for glass-house work; but he rather gathered that Mr. Heggie put the system forward in a more artistic manner. He agreed that in some cases it was a real time-saver. For example, a pattern maker of one of their clients took three days to produce a particular pattern in wood, and to produce the same pattern in plaster only occupied six hours, and as delivery of the casting was most important, they had this plaster pattern in the foundry a few hours afterwards. Another point worth considering, since it was customary in jobbing foundries to bed most jobs in, was the difficulty of bedding in plaster patterns, particularly when the plaster had not had time to get hard. In such cases the plaster pattern had to be got out in small pieces, causing much time to be taken up in finishing. Further, should the casting turn out faulty, and a new plaster pattern have to be run up, the time gained at the first would be lost, for there could be no repeats from a pattern in dozens of pieces. A friend who

had been experimenting in mixing plaster had finally settled on Keen's cement; this, mixed with plaster, gave him greater latitude in the time of forming whatever piece of work he had in hand, while the material would set extremely hard after working it for a considerable time. With ordinary plaster alone for only a very limited time could it be worked before it perished, and the resulting pattern was very soft. While he agreed with Mr. Heggie in everything that had been said about the saving of time in making plaster patterns as against wood patterns, he thought the foundry needed some consideration as regarded the cost of producing castings from plaster compared with wood patterns, and he had his doubts from that point of view whether there was a saving in cost in the long run.

Mr. D. Gordon (London) said that with regard to the deposit which Mr. Cook had referred to as having been made with a spraying machine, the simplest method, in his opinion, for obtaining such a deposit would be to prepare the surface of the plaster with plumbago, and subject it to the electrolytic process. Any desired thickness deposit could be thus obtained. Mr. Heggie had wondered why plaster was not more frequently used in the engineering pattern shop. In his (the speaker's) opinion, plaster was of too frail a nature for moulding purposes, and when used required a delicacy of touch which was not to be found in the average foundry. The contention that plaster-of-Paris could be substituted for wood for paring work, as it possessed no grain, was a falacy, as pattern work of a paring nature could be done equally as quick in wood and would be far more durable, as it should be remembered that a "dint" in wood meant a fracture where plaster was concerned. He agreed that plaster for work of a uniform character was very suitable, assuming that the number of castings required was small, also for the making up of a master pattern in metal, when great economy could be obtained. Mr. Heggie, he noticed, had mentioned nothing with regard to lifting plates and methods of dowelling. He had found in this respect that the usual lifting plate could be bedded into the plaster before it had set, with also screws in their positions, and it would be found that a perfect hold was obtained, the plaster binding around the screw helices. With regard to core-boxes there could undoubtedly be a great saving in this direction if plaster work and its possibilities were more fully understood; the possibilities of fractures due to rapping could be easily overcome by reinforcing the material with wire netting That strengthened the structure very much. Also, if Keen's cement were mixed with the material—for patterns also—greater durability would be obtained. With reference to the mixing of plaster-of-Paris, everybody seemed to know the best method to adopt, but the essential seemed to be stirring in until the material arrived at a consistency equal to cream. He (the speaker) preferred to mix plaster in the same way as a Scotchwoman mixed porridge, by sprinkling in the material with one hand and stirring with the other. He believed the hand to be preferable to a stick or spoon, as any lumpy matter could be removed. With reference to the syphon, that could be made in a more economical way than by that shown by Mr. Heggie. This method would be to form a piece of wire to the centre line of the job and place around it Plastacine formed in the required section. This Plastacine could be made by means of a straight half core-box cut to the section required. This could then be utilised as a core-stick, and the core-box cast around it in plaster. To form the pattern, Plastacine of the metal thickness could be wrapped around it, this then being moulded and cast up in plaster. The speaker illustrated the method and remarked that he did not know of a more economical pattern-producing method. Mr. Heggie had made no mention of a jelly mould for repetition work in plaster. This was an excellent method, as the material had only to be poured in and after "setting" the mould could be stripped off and utilised over and over again. He admitted it was used chiefly for ornamental work, but thought it could be used for the simpler patterns with advantage.

Mr. C. Heggie, replying to the discussion, said that, in reference to the use of soft water, if neat water only was being used the hard water would be preferable. The addition of a little lime water as suggested in the Paper would be beneficial. In reference to Mr. Mather's remarks, he did not think the extra warmth imparted by the hand had anything to do with the relative strength of the plaster. Hot water did not dissolve so much plaster as water at ordinary temperature, and when used the results were inferior. He had already pointed out the importance of correct mixing and he fully agreed with Mr. Mather that this could be done best by hand. In reply to Mr. W. H. Freeman, plaster from the Carlisle district was always good. The patterns he had been referring to were chiefly those from which iron patterns would be made. The rolled metal would be suitable to protect the plaster and could in many cases be fastened with nails. Where the plaster patterns were meant for actual use in the foundry, they could be strengthened by the use, in mixing, of various materials, five per cent. cornflour, for instance, making it hard and tough. Alum had already been mentioned and pulverised marshmallow roots, say, from 4 to 8 per cent., made the material very tough and strong. This by being soaked in a strong solution of hot water and alum, was further improved. Then again, some of the cements, such as Keen's, could be used, and brick dust, carborundum and iron siftings were sometimes added, the plaster acting as a cement to bind the particles together. In reference to the oil, he found this quite suitable. Other materials were used sometimes, such as Russian tallow and sweet oil; soft soap alone was also good and could be used with sweet oil. In regard to Mr. Dalrymple's remarks, the wheels on the template took the place of the more common guide strip and allowed the template to slip round more easily. The template, as mentioned in the Paper, was made of cast iron to give additional weight; he agreed with Mr. Dalrymple that weight in some form was necessary for such work. Replying to Mr. Riddell, it was very seldom any allowance was made for either expansion or contraction. Mr. Riddell was right in assuming that the addition of lime reduced expansion; he had by experiments satisfied himself of that. Plaster correctly mixed would give little trouble in that direction. Mr. Gordon's method of making the large syphon was neither so quick nor so accurate as the method described. In fact, it was practically impossible to do it with anything like accuracy in a reasonable time. Apparently Mr. Gordon has misunderstood many things in the Paper; the strengthening of core-boxes for instance The wire-netting idea was rather old, but it was not the plaster, as such, that required strengthening; the strength was required in the iron core-box, which would be too weak if cast without strips from the shell plaster pattern. In reference to the paring of plaster and wood, one could, of course, well imagine many patterns that should not be pared in plaster, but he would have thought Mr. Gordon had sufficient imagination to think of many patterns where the use

of plaster as described would be an advantage, especially when the comparative prices of the two were considered. In reference to lifting plates, they were quite unnecessary and unsuitable for any of the patterns described. Mr. Gordon said that some patterns might be made in loam; that was so, but very few places where this class of work was done had the necessary tackle for such work. It was quite true he had not mentioned jelly moulds; in fact, there were quite a lot of things he had not mentioned.

Votes of Thanks.

Mr. M. Riddell (Glasgow) moved a very hearty vote of thanks to the municipal authorities for the use of the rooms for the meeting, and also to Mr. Fletcher, headmaster of the School of Art, who had vacated his room for the use of the Committee and had shown his sympathy and desire to help them in every way.

Mr. J. Smith (South Shields) seconded, and the resolution was carried with enthusiasm.

Mr. W. Mayer (Dumbarton) moved a vote of thanks to the local Reception Committee for the excellence of the arrangements made.

Mr. D. Dalrymple (West Bromwich) seconded, and at Mr. Mayer's suggestion, the name of Mr.

Stoneywell Cottage: President's Country Residence.

S. H. Russell, Hon. Secretary of the Committee, was specially mentioned in the resolution.

The resolution was carried with acclamation, Mr. S. H. Russell suitably acknowledging it.

Mr. H. Winterton (Birmingham) then proposed a vote of thanks to the officers of the Association. The resolution, he said ought to have been proposed earlier, but anyhow, the private members very much desired to tender their thanks to the officials.

Mr. Bert Sperring (Portsmouth) seconded, and the vote was heartily carried with acclamation.

The President, in response, said the officers valued the members' appreciation, but they did the work because all the officers were thoroughly interested and thoroughly enjoyed it. It was a pleasure to labour for the Association, and the more they could do for it the better they would be pleased.

The concluding function on Wednesday evening was a smoking concert in the Alexandra Room of the Grand Hotel, at which there was a very large attendance, including many lady friends. The talent was the highest available, the vocalists being exceptionally gifted artists.

DRIVE TO MARKFIELD.

Thursday was devoted to a drive round Charnwood Forest, the excursion being enjoyed by members, their wives and friends, to the number of 120. The visitors were favoured with perfect weather. The party started from the Grand Hotel at half-past ten, and drove to Charnwood Forest by way of Anstey, visiting the Cropstone Reservoir, whence Leicester gets a part of its excellent water supply. The reservoir was reached after a run of about three-quarters of an hour. By special leave of Mrs. Gray the motors were driven through Bradgate Park; here the visitors were on famous historical ground. The whole park and grounds had been practically unchanged since Lady Jane Grey spent her girlhood

Council of British Foundrymen's Association.

there in the 16th century, and the ruins of the house, in which the famous lady was born are still to be seen. The park is said to be unchanged in appearance, and to have had the same enclosure for something like a thousand years. A herd of fallow deer were seen lying under the shade of the trees as the party drove through. By the kind invitation of the President and Mrs. Gimson, the party were entertained to lunch in a marquee erected in the grounds of Stoneywell Cottage, Markfield. This is a summer home erected by the President about fifteen years ago, in the heart of the forest, at a height of

Markfield Excursion.

Mr. W. Mayer (Vice-President), Mr. S. A. Gimson (President), and Mr. J. Simkiss (Lancashire Branch President).

650 ft. above sea level, with a fine view extending over 20 miles of hills and dales.

Of this cottage, Mr. Walter Crane said in October, 1901, "How charming a cottage could be made—how picturesque and pleasing, though quite new, how perfectly in keeping with its surroundings and fitted to its site—he lately had an opportunity of seeing in

the neighbourhood of Leicester, designed by Mr. Ernest Gimson."

Since the cottage was built, in 1899, constant and very successful efforts had been made to increase the beauty of the ground without introducing anything which does not harmonise with the natural conditions of the neighbourhood. The gorse, bracken and heather have been allowed to remain, daffodils have been sown indiscriminately in the grass, and hundreds of young trees of over twenty varieties have been planted, which already add greatly to the beauty of the grounds, and will do so increasingly as time advances. The same sense of fitness and the same true artistic feeling are shown in the furnishing of the cottage, as are displayed in the design of the building and the treatment of the grounds. The dictum, "Have nothing in your house which you do not know to be useful or believe to be beautiful," has been followed and improved upon, for here the useful is also beautiful. Most of the furniture has been constructed by artist craftsmen, and all has been selected with discernment and evident appreciation of fine workmanship. There is an almost entire absence of decoration, but the whole interior is marked by simplicity, appropriateness and beauty.

After the luncheon, a hearty vote of thanks to Mr. and Mrs. Gimson was proposed by the SENIOR VICE-PRESIDENT (Mr. Mayer), seconded by MR. COOK and heartily carried.

The compliment was acknowledged by the PRESIDENT, who said that he and his wife had been honoured by their visit, and they would have been greatly disappointed if their invitation had not been accepted by everybody. Mrs. Gimson also responded briefly.

MR. C. JONES, Past-President, in a very humorous speech, conveyed the thanks of the ladies for the privilege of being allowed to accompany the members. This was seconded by MR. BUCHANAN, supported by Mrs. Bagnall in a charming speech, and heartily carried.

These compliments concluded, the party re-entered the motors and drove back to Leicester, where they finally separated.

[The accompanying views are from photographs by Mr. Alf. Harrison, Secretary of Manchester Branch.]

Visits to Works.

Descriptions of the works of The British Thomson-Houston Company, Rugby; the Midland Railway Company, Derby; and Messrs. S. Russell & Sons, Leicester, which were visited by the members, are given on other pages of this issue.

ANNEALING PROCESS FOR MALLEABLE CASTINGS.—Mr. E. L. Leasman, in a Paper on this subject read before the American Foundrymen's Association, drew the following conclusions after experiments with iron, the analysis of the hard castings of which was about:—Total carbon (combined), 2.75 to 3.25; silicon, 0.50 to 1.00; sulphur, below 0.08; phosphorus, below 0.225; manganese, 0.15 to 0.40:—(1) The nature of the packing does not affect the interior structure of the iron; while the surface or "skin" effect may vary from pure ferrite to a pearlitic structure. (2) Packings like rolling-mill scale and fire clay give as good results as any, and have the added advantage of being cheap. Of these two packings, fire clay would be the better because it packs closer and more effectively prevents access of the oxygen of the air to the specimen or casting. (3) Castings may be malleableised without the use of any packing, but a good muffle furnace should be used to keep down the oxidation of the surface of the castings. (4) Air-tight containers or those as nearly so as possible should be used to keep down oxidation effects. (5) A temperature of 1,550 deg. to 1,660 deg. F. has proven to be the best temperature to use for iron of the analysis previously given and under the conditions tested. This range insures a complete breaking down of the carbide. (6) A temperature below 1,400 deg. F. did not cause a complete breaking down of the carbide structure; and even prolonged heating would not have produced a malleable structure when as low as 1,000 deg. F. (7) At temperatures of 1,400 deg. to 1,500 deg. F. there is danger in not getting a good malleable structure in those castings farthest from the source of heat and the oven walls. (8) The above conclusions are understood to be based upon annealing small specimens in small ovens, in which temperature variations are more marked than in the large, almost uniformly heated ovens of commercial work. (9) The time of cooling from the annealing temperature to 1,200 deg. F. is the most important variable in the process. (10) A rapid rate of cooling, even when sufficient heat and time of annealing is used, forms a pearlitic or "steely" structure. (11) The time of cooling to 1,250 deg. F. should be about 42 hours. The cooling below this temperature may be rapid, and not materially affect the malleable structure. (12) A period of from 36 to 42 hours gave the best results for this range of temperature. (13) One experiment showed that good malleable structure could be obtained in 20 hours, using a temperature of annealing of 1,800 deg. F. (14) The period of annealing is entirely dependent upon the temperature or annealing and the type of furnace used.

RECOVERY OF TUNGSTEN FROM STEEL SCALE.—Writing in "The Iron Age" on this subject, Mr. R. J. Wysor gives details of a process for the profitable reclamation in the electric furnace of valuable alloying elements, and summarises the results of his investigations in the following terms:—(1) There is a considerable and increasing tonnage of valuable high-speed and other tungsten steel scale produced each year. A large percentage of it can be accumulated, chiefly in hammer shops, without much admixture of other scale or foreign material. Recovery of tungsten and other metal values from such material has been a difficult problem. (2) In the presence of a suitable reducing agent, practically the entire percentage of tungsten, chromium, vanadium, and iron in steel scale may be recovered profitably in an electric furnace. This may be accomplished by making heats in which the greater part of the cold charge consists of the scale itself. In such cases the percentages of alloy metals in the steel produced should be somewhat similar to those in the original metals from which the scale resulted. Steel thus produced can be used in making new crucible heats, or in case alloy steel or ferro-alloy heats with the same alloying metals are to be made direct in the electric furnace, additions of a few hundred pounds of scale may be made to each heat. (3) With the carbon in the bath under control by the aid of preliminary carbon determinations, it seems practicable that direct electric-furnace heats of specified composition can be made by using alloy-steel scale of known composition as the principal constituent of the charge.

The Foundries of the British Thomson-Houston Company, Limited.

The foundries at the Rugby works of the British Thomson-Houston Company, Limited, assumed their present proportions about two years ago. The original foundry, now known as the "A" Bay, a substantial and particularly roomy building 280 ft. by 50 ft., was erected in 1902, at which time the works' demand for castings was approximately 20 tons per week, so that for a considerable time the foundry was able to meet the growing demands of the business. Some two years ago, however, it was found impossible to keep the output in line with the demand, and important additions were made to both buildings and plant. A two-storey building, 280 ft. by 70 ft., built on to the existing foundry, and with

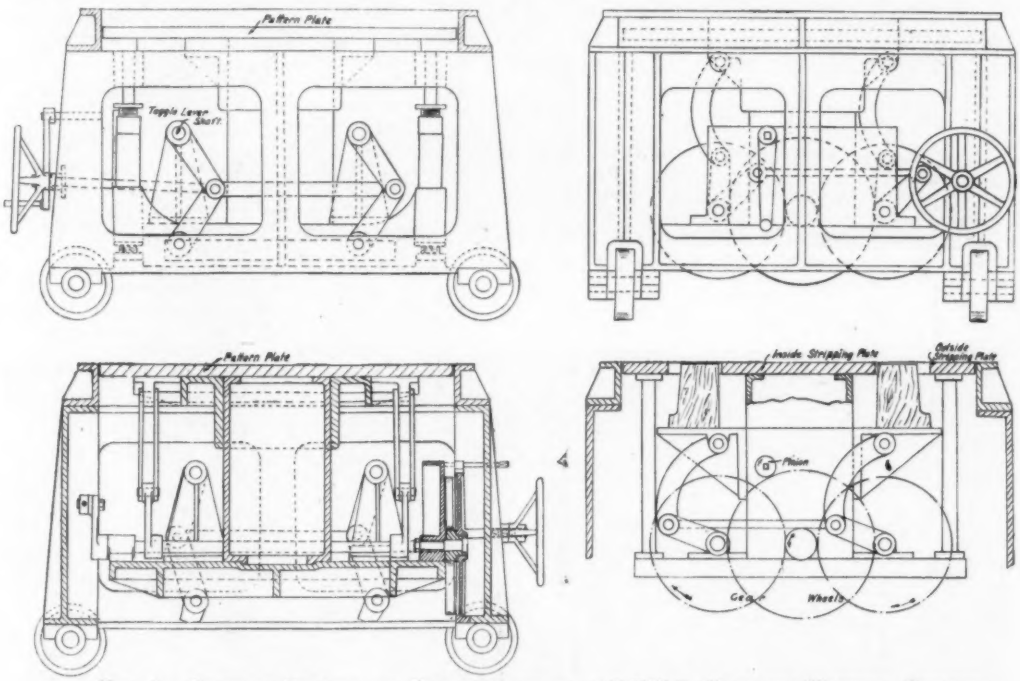


FIG. 1.—SHOWING DETAILS OF CONSTRUCTION OF "B.T.H." MOULDING-MACHINE TROLLEY.

thoroughly up-to-date equipment was installed. The present output of the foundries is about 110 tons of iron castings, in weights ranging up to 25 tons, and 6 tons of brass castings ranging up to 10 cwts. in weight.

"A" Bay is laid out for the production of the heavy castings. The floor is served by a 30-ton and a 10-ton electric crane, whilst 5-ton and 3-ton jib cranes are secured to each of the standards. Two London Emery Works Company's turnover hydraulic moulding machines, which take pattern-plates up to 5 ft. square, are installed.

"B" Bay is entirely given over to the work of the "B.T.H." patent moulding machine. This machine, which we illustrate in Figs. 1 and 3, is constructed so as to permit four squads of men working on it at the same time. Four sets of rails are provided and laid at the same level as corresponding rails attached to the press table. The operation of the machine is as follows:—The pattern plate is set, the moulding box placed on and filled with sand, the machine then being run under the press. One set of rams is put in operation, and this raises the moulding machine until the moulding box comes up against the entablature of the press. The other ram is then operated, and this raises the pattern plate to the level of the bottom edge of moulding box, thereby consolidating the mould. The machine is then run out and another takes its place under the press. The pattern can then be drawn by the stripping-plate arrangement, or, if necessary, drawn by hand in the usual way. This method of bottom-ramming allows of large moulds being made quite readily in barred boxes on moulding machines. The moulds are so uniformly rammed that in the bulk of cases venting is found to be quite unnecessary, the mould being hardest next the pattern and gradually lessening in density towards the outer surface, thereby permitting the easy escape of the gases and ensuring sound castings. Loose pattern pieces can be perfectly rammed by this process, owing to the side-ramming action the sand is given when confined and under compression. The machine also reduces the pattern cost considedably, half-patterns only being necessary in a great number

FIG. 2.—MAIN "A" BAY IN IRON FOUNDRY; B.T.H. WORKS.

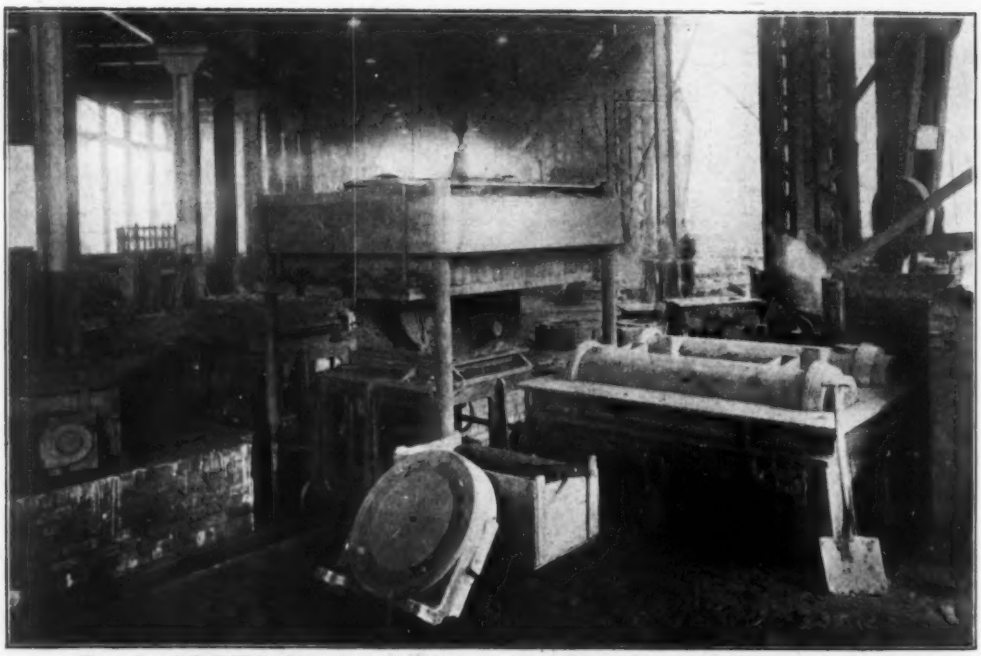


FIG. 3.—"B.T.H." MOULDING MACHINE; SHOWING TRUCK IN POSITION FOR RAMMING.

of cases. The changing over from one size of the box to another is only a question of a few minutes. The pattern plate is adjustable, and thus allows moulds being rammed to any required density. A large variety of work is at present being done on this machine, including turbine casings, diaphragms, field frames, stator frames, end shields, pedestals, base plates, etc. The largest box at present in use is 7 ft. by 7 ft. by 27 in. deep each half. So successful has the machine proved that the company are considering a further installation to deal with much larger work. The hydraulic portion of the plant was supplied by Messrs. Henry Berry & Company, Limited, Leeds.

A distinctly ingenious idea in evidence in this bay is the production of the top halves of turbine casings. These are swept in loam, the saving effected by such an arrangement being very considerable.

The core-making shop is housed in an annexe 250 ft. by 40 ft., the floor of which is served by a 4-ton

FIG. 4.—VIEW ON FIRST FLOOR OF FOUNDRY, SHOWING OVER-HEAD RUNWAYS; B.T.H. WORKS, RUGBY.

crane. The machines comprise both Mumford & Samuelson jolt rammers. There are three large drying ovens, 25 ft. by 21 ft., and two ovens for the smaller work, 9 ft. by 6 ft. These small ovens are served by travelling carriages which run on ball bearings.

Bay "C" is entirely devoted to loam moulding; a 2-ton crane serves the floor. The first and second floors, which are above bays "B" and "C," are entered by outside stairways, but they are also served by a passenger lift. Immediately at the entrance on the first floor are the foundry offices, which comprise manager's, clerical, and production staff offices. It may here be noted that all work coming into the foundry carries with it a definite promise of delivery, and it is the duty of the production staff to follow up and see that the dates of delivery are observed. On this floor are installed a battery of moulding machines, comprising three each of Pridmore & Samuelson turnover machines, three Tabor machines, and one London Emery Works Company flaskless machines. Each of these machines is served by an overhead traveller, with runways at right angles to the length of the shop, whilst the whole floor is served by a very comprehensive system of runways by which iron is conveyed to the moulds. All the machines are served

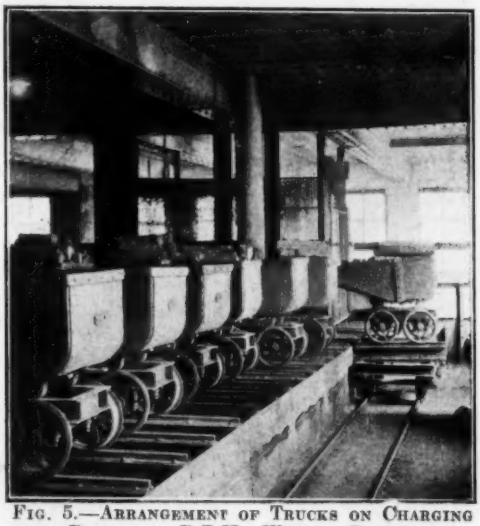


FIG. 5.—ARRANGEMENT OF TRUCKS ON CHARGING PLATFORM; B.T.H. WORKS, RUGBY.

by the sand plant, to which reference will be made later.

The top floor is divided into two bays, the one devoted to the production of light castings from 6 cwts. downwards. This floor is also served by runways.

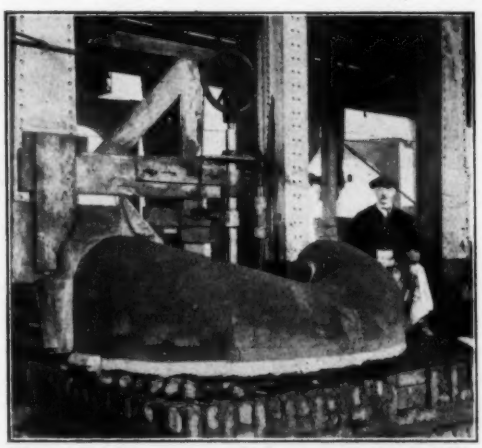


FIG. 6.—SWEEPING A LARGE CORE; B.T.H. WORKS, RUGBY.

The machines comprise a Samuelson, a Tabor and a London Emery Works flaskless; on the last-named two men turn out from 450 to 570 moulds (according to the class of work) per day.

The second bay is given over to the brass foundry. The furnace equipment consists of four "M.R.V." furnaces, *i.e.*, three of 440 lbs. and one of 220 lbs., and two "B.T.H." furnaces, each of 100 lbs.

The iron for the iron foundries is brought down in one of two cupolas by Evans, Manchester, with runs on rails in the pit. Each cupola is provided with two hinged spouts, so that when a big cast is being

FIG. 7.—BRASS FOUNDRY; B.T.H. WORKS, RUGBY.

melting capacities of 12 tons and 8 tons per hour respectively. Blast is supplied by Roots blowers. made the second spout may be brought into service to keep the shop supplied.

FIG. 8.—TOP FLOOR OF IRON FOUNDRY; B.T.H. WORKS, RUGBY.

A pit extends across the front of both cupolas to a point below the hoist which serves the upper floors, the ladles being conveyed to the hoist by trolley which

The hoist for conveying the metal to the first and second floors is controlled from the last-named, where an indicator is installed. In the centre of this indi-

cator are pilot lamps, which are operated by the crane on the ground floor, so that if the crane travels beyond a certain point on that floor the pilot lamp lights up, warning the man in charge of the hoist to suspend operations.

The raw material is delivered at the rear of the foundry, and the iron stacked according to the particular analysis. A pit provided with a rail track runs the full length of the siding, and travelling along the track is a bogie weigh, the top of which is provided with rails laid at right angles to the pit. The material is loaded into a four-wheeled truck and the bogie travelled to the rails which feed the furnace hoist. The charging platform is provided with a number of lines of track, each of which is devoted to a particular quality of iron, and from which the trucks are taken to the cupolas as required.

The sand-treating and handling plant, which was supplied by Messrs. Buchanan & Son, Liverpool, is of a very elaborate character, in which efficiency has certainly been made the dominant feature. To make the system more lucid it will be advisable to divide the description into two parts, *i.e.*, the shop sand and the facing sand. The shop sand is shaken out from the boxes and falls down a shoot to a series of valve-controlled hoppers arranged above a belt conveyor in a chamber below and extending the full length of the foundry floor. The band conveyor feeds an elevator, by which the sand is raised to a revolving riddle, the tailings from which pass through a magnetic separator. The fine sand passes to a hopper, from which it is fed to a spiral mixer. Into the latter the necessary moisture is introduced, and from this it passes to a disintegrator, from which a further elevator delivers it to a scraper conveyor, by which it is distributed to any part of the foundry.

As regards facing sand, the new sand is fed into a revolving dryer, installed outside the building, from which it is elevated to the riddle, the fine sand passing into one division of a divided hopper, the outlet from which forms a measuring valve, the other division receiving the old sand.

From this hopper the proportions of old and new sand, which are automatically regulated, pass to a spiral mixer, where the coal dust is added by means of a spray valve and the necessary moisture introduced. From the mixer the sand is raised by an elevator to the sand mills or bins as required. The work on the various floors is so arranged that only one class of sand comes into the same basement hopper. The various units in connection with the plant are driven by 18 motors.

Some record outputs have lately been obtained at the Normanby Park Steel Works, Scunthorpe, of John Lysaght, Limited. The first was for one week's output of three furnaces of 50 tons capacity, the total being 2,474 tons of basic open-hearth steel. This was accomplished for the week ending May 9. The following week, with four furnaces, the output reached a total of 3,043 tons.

In an order made by Mr. Justice Astbury, dated May 28, concerning the Haybridge Iron Company, Limited, it was ordered that the cancellation and reduction of the capital of the company be confirmed. The capital of the company is now £7,520 divided into £440 stock and 708 shares of £10 each instead of the former capital of £90,000 divided into £7,500 stock and 1,100 shares of £75 each. At the time of the registration of the minute the whole of the £440 stock and 435 of the shares were issued, £10 (fully) paid, while the remaining 273 shares were unissued. The reason for the cancellation and reduction of the capital of the company is that the amount by which the capital is reduced is now unrepresented by available assets.

Steel Castings direct from Iron Ore.

At Toronto, Canada, the Moffat-Irving Steel Works, Limited, are successfully operating a process for the electro-thermic reduction of iron ores and their direct refining to steel. The object of the process is to avoid the concentrating and briquetting of the Canadian iron ores which is necessary for their smelting by the ordinary blast furnace. The form of furnace used is based on the principle of the electric pig-iron furnaces in Sweden which have already been described in our columns. The crucible of the furnace is built on a base of concrete, and above this are a few courses of hard-burnt red brick, and finally the silica brick forming the main body of the crucible. The hearth is of rammed magnesite, furnishing a basic lining. The ore and limestone are mechanically fed into the upper stack and the carbon is similarly injected at the top of the crucible. The three electrodes (3-phase current is employed) are projected into the crucible at an angle of about 60 deg. The ore particles as they fall come into contact with a strongly reducing hot atmosphere of carbon monoxide gas, and are partly reduced thereby, the final reduction taking place in the crucible.

It is stated that the ultimate refining in the furnace produces a steel equal to crucible steel or any other electrically-produced steel, the average analyses of three heats being given as follows :—Carbon, 0.27 per cent.; manganese, 0.74 per cent.; silicon, 0.27 per cent.; sulphur, 0.010 per cent.; phosphorus, 0.031 per cent. Tests of steels made in this furnace have been published by Prof. T. R. Louden, of the University of Toronto. The figures given in the following table relate to unannealed or "green" steel and the same steel annealed :—

Unannealed Steel.

Heat.	Carbon per cent.	Elastic limit,** lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation in 2 in., per cent.	Elastic ratio, per cent.
167	0.23	53,300	68,950	12.50	77 2
—	0.18	47,500	63,900	15.00	74.3
171	0.31	56,000	82,800	12.50	67.6
175	0.12	49,200	53,700	17.50	91.6
178	0.23	52,500	68,750	13.75	76.3
181	0.35	53,300	84,600	10.00	63.0
184	0.21	59,450	80,050	15.00	74.2
187	0.29	49,950	74,850	15.00	66.7
		Same Steel Heat-Treated.			
167	0.23	52,300	72,100	26.25	72.5
—	0.18	46,300	66,850	25.00	69.4
171	0.31	53,000	84,500	22.50	62.8
175	0.12	47,050	57,450	35.00	81.8
178	0.23	53,600	70,500	27.50	76.0
181	0.35	53,950	88,400	20.00	61.3
184	0.21	59,200	81,500	22.50	72.6
187	0.29	50,500	76,950	30.00	65.9

The tests were made by Professor Louden himself, and are useful testimony to the quality and purity of the steel.

LENNOX FOUNDRY COMPANY, LIMITED, Glenville Grove, New Cross, London, S.E.—A well illustrated catalogue of "Tantiron" specialities has been issued by this Company. "Tantiron" alloys are well known for their acid resisting properties, and find wide application in plants handling corrosive liquors, distillation and condensing plants, etc. The company have succeeded in producing an alloy which will resist hydrochloric acid, and they have also succeeded in making "Tantiron" soft enough to be machined in the ordinary way like cast iron.

SHALLY & COMPANY, 55, Great Thorn Street, Hull.—A blotting pad illustrating wire brushes and brooms for foundry use.

FIG. 1.—FOUNDRY OF MESSRS. S. RUSSELL & SONS, LEICESTER.

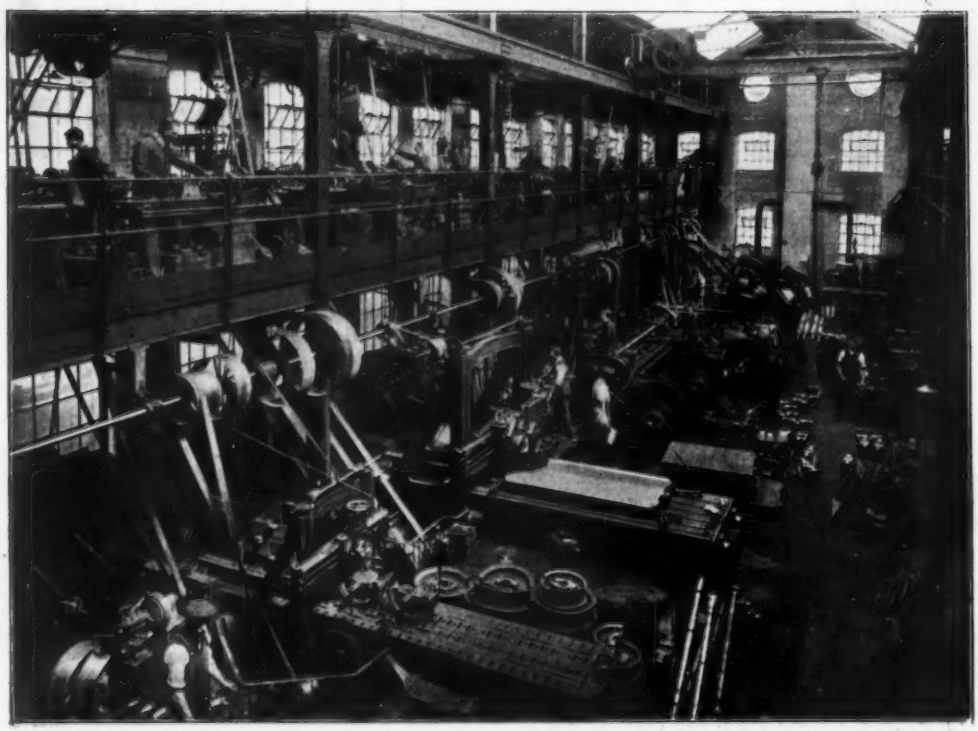


FIG. 2.—MACHINE SHOP; WORKS OF MESSRS. S. RUSSELL & SONS, LEICESTER.

The Foundry of Messrs. S. Russell & Sons.

The Bath Foundry, Bath Lane, Leicester, is the development of a business established by Mr. Russell, in Vauxhall Street, Leicester, half a century ago, for the production of iron castings for the trade. When the business was transferred to the present works, some 30 years ago, the scope was considerably extended, and although a large proportion of the output is still on general trade account, the firm are at the present time doing a considerable amount of Admiralty work, such as bedplates for lighting sets, fans, etc., the foundry being equal to castings up to 5 tons. In the brass foundry wagon bearings are the staple production, though all descriptions of castings for the trade are produced, up to 4 cwts. in weight.

The works are very conveniently situated near the centre of Leicester, and have excellent transport facilities, being bounded on the one side by the canal, so that water-borne goods can be delivered or despatched to or from each foundry direct. The Leicester station of the G.C.R. is also in close proximity. The offices, which comprise the usual complement, front on to Bath Lane, from which also there is a gateway entrance to the works.

The foundry proper is divided into two main blocks of buildings. That adjoining the offices consists of the foundry for small work, the machine-moulding shop and brass foundry. The second block of buildings consist of the foundry for large work, the stores, the fettling shop and the sand-mixing shop. These buildings, which occupy a floor space of 144 sq. ft., are built round three sides of the yard. The brass foundry, which immediately adjoins the offices, contains a 5-pot crucible furnace. The whole of the work done here is hand moulded.

The stores for raw material are situate in the yard at the side of the foundry, a building 96 ft. by 48 ft., divided off into two departments for the floor and bench moulding respectively, and employing about 30 bench moulders. The drying stoves and core ovens are coke-fired. In the machine-moulding shop are installed five machines by the London Emery Works Company, the largest of which will take plates up to 3 ft. 9 in. by 2 ft. 6 in. This machine is jarred by compressed air. There is also a pair of special wheel-moulding machines. These foundries are served by one of the three cupolas, each of which has a melting capacity of 3 tons per hour. Blast is supplied by a fan made by the firm themselves, which is belt driven by an 11-h.p. motor.

The large foundry is served by a 5-ton manual crane and a 12-ton rope-driven crane; these were built by Messrs. Russell. The three drying stoves are coke-fired. Of the two cupolas each having a melting capacity of 2 tons per hour, one acts as a stand-by. The cupola in blast has eight 4-in. tuyeres, which are contained in a belt built round the cupola; a 2½-in. pipe extends from this belt into the cupola at a point above the melting zone, and this auxiliary air supply ensures the burning of the gases at the particular point, an arrangement which has been found to give very good results in practice, as the iron is nicely hot before it enters the melting zone. The arrangement of the spark arrester is very simple and effective. The cupola tops are covered with a domed chamber, provided in the mid-position with a chimney which is fitted with baffles; and built into the floor of the chamber immediately below this is the dust hopper. The top of the cupola not blowing is covered, and a side door in the chamber above the cupola blowing is opened, which provision is found to entirely eliminate down draught.

The sand-mixing shop contains a sand mixer by the London Emery Works Company, and a sand-grinding mill. The sand bins are placed immediately at the gateway entrance. The buffs in the fettling shop and the sand-mixing and grinding plant are

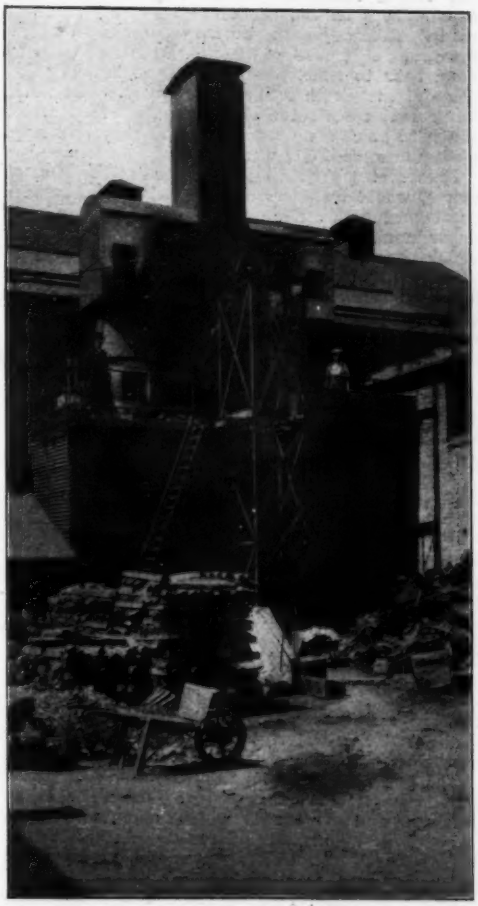


FIG. 3.—CUPOLA-CHARGING APPARATUS; WORKS OF MESSRS. S. RUSSELL & SONS.

driven off counter shafts by an electric motor. The power crane in the foundry, the cupola hoist and the Piftin blower are driven off a gas engine. Power for the motors is taken from the Tramway Company's mains.

On the opposite side of Bath Lane the firm have more recently built a machine shop. This has the usual complement of machine tools, and is devoted mainly to the building of fans and general repair work. An addition is being made to this portion of the works, which, when complete, will become the erecting shop.

B

The Locomotive Works of the Midland Railway Company, Derby.

The Locomotive Works at Derby were really established with the amalgamation of the three independent companys—the North Midland, the Midland Counties, and the Birmingham and Derby Junction Railways, which in May, 1844, became the Midland Railway Company, as we know it to-day, although the North Midland had their general offices and repair shops on the site of the present works. The works' offices adjoin the works proper, and these, with somewhat extensive additions which have been made from time to time, occupy the same building as did those of the North Midland Company. The works as at present constituted cover an area of 80 acres, of which 20 acres are under roof, and they find employment for some 4,600 workmen.

Immediately adjoining the offices are the locomotive stores, where all parts are stocked in numbered and catalogued racks. Requisition notes from the various departments are made upon different coloured forms, which greatly facilitates classification, the notes being afterwards sorted by boys—first for the catalogue number and afterwards for the charging. The stores proper occupy two floors, the basement being used for storing consumable material, such as brushes, etc.

Adjoining the stores is the motor building and repair shop, all motors being of the Company's design and standardised. The tool equipment comprises lathes, drilling, slotting, milling, and grinding machines, etc.; they are driven through line shafting operated by motor. The floor is served by a 5-ton electric crane, by Booth Bros., which is operated from the floor level.

By way of the copper-smith's shop one enters the brass-casting shop. Here there are two "Charlier" oil melting furnaces and four crucible furnaces, the waste heat from these last being used to heat the core-drying oven. Other auxiliaries are a "Brookhouse" pneumatic and various other moulding machines. The total output of the foundry is about 4 tons per shift, of all metals and alloys. A special feature is the burning in of brass liners for the big end brasses, no whitemetal being used in this case. All material is kept in a locked store in the shop, and a monthly balance-sheet is taken of the stock. At the rear of the building is a coal-fired furnace for the recovery of the whitemetal from bearings and journals, which amounts to some 10 cwts. per week. The whitemetal shop is furnished with 10 pots, gas-fired from coal gas, blast being supplied from the motor-driven fan which serves the brass-casting shop. In the yard are sand-blast cleaning and scrubbing machines, and melting furnaces for the recovery of zinc scrap and whitemetal respectively, these being fitted with rose burners and fired with coal gas.

An interesting feature of the yard plant is to be noted in the machines for the recovery of metals from refuse. All the refuse from the brass foundry, and even the boiler scalings, are here treated, the latter being dealt with separately for the recovery of copper. Two distinct methods are employed. In the first the sand, etc., is ground up in a rotary mill, and the ground sand put into a circular pan to be treated with a revolving spray of water; carried below the washing pan is a bucket receptacle into which the heavier material or metal falls, whilst the sand is washed away. In the second method the two operations are performed simultaneously, the apparatus being contained in a cast-iron box, into which the material is introduced; the rollers revolve in running water, the sand is washed away, and the metal sinks to the bottom of the mill to be removed periodically. After leaving the mill the material is treated by magnetic separators of the revolving type, and is then disposed of, the final mixture containing about 60 per cent. of metal.

Passing the scrap bunkers, which are arranged along the siding and provided with openings for loading direct into the trucks, one enters the iron-foundry, a lofty, well-ventilated building 250 ft. by 95 ft., comprising two bays, the central pillars of which support the crane runway which carries a 25-ton rope-driven crane. This, with three hydraulic cranes with a jib radius of 20 ft. and a lifting capacity of 6 tons, serves the bay devoted to the heavier castings. The equipment includes a wheel-moulding machine, a "Mumford" jolt-ramming machine used for the locomotive chimneys, two "Brookhouse" pneumatic machines for the small work, and a number of hand moulding machines of the Company's own make. The firebars are moulded by machine through a stripping plate and put on to a chill. The foundry is served by two cupolas, each of a capacity of 6 tons per hour, material being conveyed to the charging platform by hydraulic hoist, and blast supplied by a motor-driven fan running at a speed of 1,300 r.p.m. Hydraulic power is supplied by a pair of "Tannett-Walker" engines.

The core shop contains two of "The Best" core machines, by Messrs. Evans, of Manchester, and two core-making machines of the Company's own manufacture.

Adjoining the main foundry is the chair foundry, a building 250 ft. by 45 ft., which is devoted entirely to the production of chairs and brake-blocks. It is served by two cupolas, for which blast is also supplied by the "Tannett-Walker" blowing engines; the weekly output of this foundry is 310 tons of chairs and 25 tons of brake-blocks.

At the end of this line of shops is an extensive tract of land which serves for a general storage ground for the locomotive castings, etc.

The smiths' shop contains 76 hearths, hydraulic spring-bending machines for locomotive springs, and 10 steam hammers ranging from 7 cwts. to 50 cwts. A small shop adjoining is used for welding, etc.

Other shops are the boiler shop, one end of which is devoted to testing; the axle-turning shop, which is served by a mono-rail electric crane; wheel-fitting shop, consisting of two bays, each of which is served by a 10-ton overhead crane; the erecting shop, 450 ft. by 140 ft., which is covered by three bays, of which that devoted to heavy work is served by four cranes, two each of 50 and 10 tons on the high and low level runways respectively, the other bays being each served by three 25-ton cranes on a single runway. Adjoining is the machine shop containing some 550 machine tools, most of which are driven through line shafting from the shop engines; the larger tools, however, are operated by independent motors.

The Company's power station is separated from the Works by the Derby Canal, and connected therewith by an electric overhead crane, the runways of which serve to support the bucket-elevator and conveyor used to transport the boiler fuel.

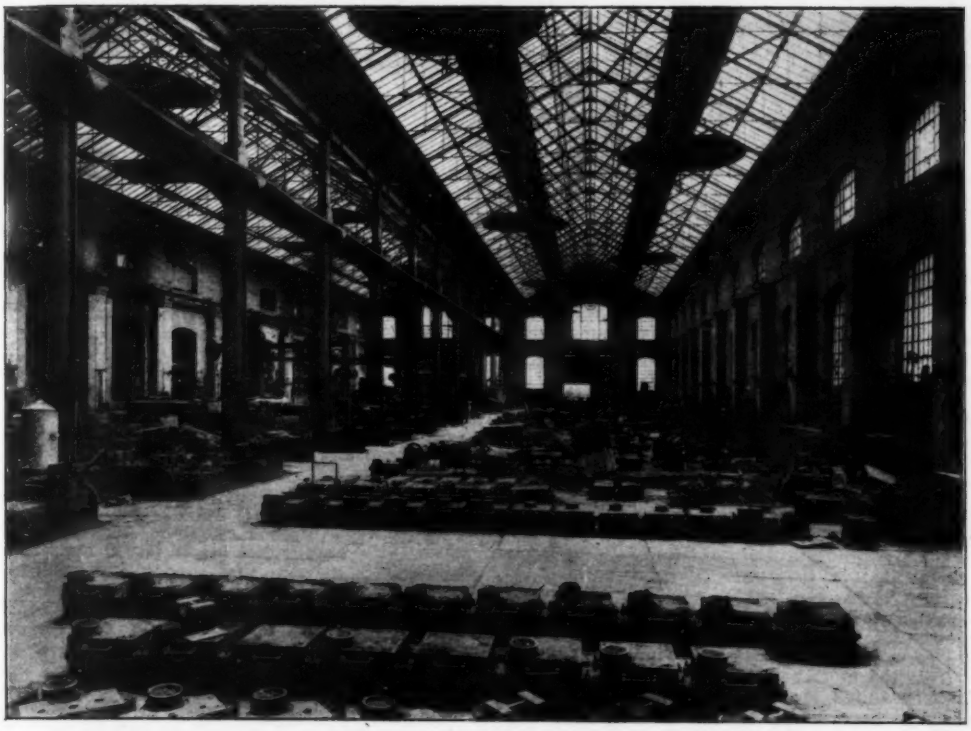


FIG. 1.—IRON FOUNDRY; MIDLAND RAILWAY WORKS, DERBY.

FIG. 2.—MACHINE SHOP; MIDLAND RAILWAY WORKS, DERBY.

Annealed Castings for Textile-Machine Spindles.*

By Robert Buchanan (Birmingham).

The cast iron used in spindle making is always annealed, and is known under the generic name of "black iron." That cast from part hematite, or from irons with about 1 per cent. phosphorus, exhibit a fine velvety fracture after proper annealing. In such a case there is practically no combined carbon present, all the carbon being in the form of graphite and annealing carbon. It is this complete separation of the carbon which principally gives the iron its velvety appearance when broken. One firm which produces these castings states that they may be machined at 600 ft. speed per minute. In a good sample of this kind I have cut off a small paring with an ordinary pocket knife. I am aware that some makers use annealed castings made from their ordinary mixtures. These are not so dead-soft as the true "black" iron, and do not machine so easily and quickly, but they have undoubtedly more wear in them; that is, they have a longer working life. Naturally firms who are spindle-makers only are more concerned about the speed of production than about the after life of the spindle. I have, however, heard complaint made that the spindles can be too soft from the users point of view.

An iron suited for these castings and combining the best average qualities for rapid production and long life in work will approximate to the following analysis :—

	Per cent.
Silicon	not exceeding 2
Phosphorus	" " 1
Manganese	.. .. 0.85 to 1
Sulphur	.. .. 0.08
Total carbon ..	as high as possible.

As I have already said, the annealing is for the purpose of changing into the form of "annealing" carbon, all the combined carbon present in the casting as originally cast. One could probably do that without annealing, by the use of high-silicon iron, say, 3.25 to 3.5 per cent., but such an iron would be deficient in total carbon. Partly from this cause, and partly from the fact that such a percentage of silicon would itself conduce to a harder product, the resulting iron, even when annealed, would not be so soft as one wherein the silicon was at the normal amount of 2 per cent. In short, the silicon should be present only to such an amount as will make certain the castings will be grey when cast.

The percentages of phosphorus, manganese and sulphur given above are practically neutral, but with a tendency to increase the wear of the metal. Of the moulding of the castings little need be said. They present no difficulty unless it be in the case of "long collars," and even in this case it is long cores of small diameter which present the difficulty. It will be in the recollection of the members that when we visited the works of Messrs. Tweedale & Smalley, Limited, Castleton, near Manchester, some few years ago we there saw in use a core-making machine successfully producing these cores. I was particularly interested in this machine, as I had recently failed to have similar cores made successfully, in ordinary core boxes. We also tried making these cores by means of a "Wadsworth" core-making machine. The cores were made fairly well, but as our conditions did not allow us to cast the boxes on end, the cores lifted in the middle owing to there being no core rod in them. In the finished spindle there must be absolute balance, and for this they are carefully tested before being passed; so a thick and thin side on any casting at once condemns it. I have been informed that there are always plenty of orders for anyone who can tackle "long collars" successfully.

Annealing Cans.

The annealing cans into which the castings are packed, are best cast of white hematite or other metal with a high melting point. In the "Black Country" these have also usually a large proportion of waste malleable castings melted along with the hematite.

These cans retain their shape well considering the service they do, and are still white when broken up at the end of their service. Sometimes a round can may be beaten oval before it will break. When being made they are cast in open-top moulds made in sharp sand.

When castings are long the can is heightened by means of a ring or bottomless can of similar material being placed on top of a can having a bottom. In some places the cans have no bottom cast on, but use loose bottom plates which rest on a ring cast inside the can. By this means any height of can may be built up, and by putting the top can with an internal ring at top, one of the loose plates can be used as a cover, and so luted on with fireclay. The annealing cans are of varied shape; some firms have them round, others rectangular, and in one case I have seen they are oval.

When the cans are large, snugs or swivels are used by which the cans are withdrawn from the annealing oven by means of "tongs" 10 or 12 ft. long, mounted on a pair of wheels. The tongs swivel on the axle on which the wheels are placed. When annealing ovens are continuous in action, these tongs are necessary for the withdrawal of the cans. The tongs are run up to the oven, the ends put under the snugs or swivels on each side of the can, and so the can is withdrawn. On oval cans there are two swivels on each side, each being similar to those on a moulding box. This allows the can to be balanced during withdrawal. The cans sometimes have lids which are luted on with fire-clay, in other cases they are left open-topped. In the case of non-continuous annealing ovens, these are entered when they have cooled down sufficiently, and the cans and their contents carried out by hand.

Packing the Cans.

Various packing materials are in use. Small gas coke which has passed through a quarter-inch riddle is one. Others use cast-iron borings. In one case I found a mixture of cast-iron turnings and red hematite ore was being used. This was a wrong material. It was thought that because red hematite ore was being used when annealing malleable-iron castings, therefore it was a suitable material in which to anneal these castings; but the fact was overlooked that with the castings now being considered retention and not lessening of the carbon was desired.

* Read before the British Foundrymen's Association; Leicester Conference.

The sole object in packing the castings is that they may not twist or warp during the anneal. Long castings should be placed vertically in the cans.

When used as a packing material, small coke "sags" under heat more than do cast-iron turnings or borings. This induces warping of the castings, especially if the oven has been over-heated.

Annealing Ovens.

These may be divided into non-continuous and continuous. In the non-continuous oven the cans are allowed to cool down in the oven. This is the ideal way to get dead-soft castings. These ovens may be, and usually are, in a battery of five or six, connected by individual flues to one central chimney stack. The ovens are known as "25-can ovens," or "40-can ovens," according to capacity. The fire-grates are on each side of the oven, are sunk about 4 in. below the floor level, are 12 in. wide, and extend the whole length of the oven. That is, the fire-grate is about 9 ft. long by 1 ft. wide. Before the cans are put into the oven lump coal is piled about 4 ft. high over each fire-grate. This is all the fuel used; there is no subsequent firing. The fire doors are used only to start the fire and to remove clinker, etc., after the oven has cooled down. When the two walls of coal have been built the cans are placed in position. As this is done by hand, the highest point of the roof inside does not exceed 6 ft. 6 in. to 7 ft.

The cans, which are ready packed with castings embedded in coke dust of cast-iron borings, are placed along the sides next the coal, and at the end furthest from the entrance. This is continued until the oven holds as many cans as it will contain. The opening is now bricked up loosely, and daubed with loam or mud. About 9 in. above the floor level a brick is left sticking out so that it may be readily removed when the "soaking" begins. In about 12 hours from being lit up, the coal on each side of the oven is a glowing mass, and all visible smoke has gone. The interior of the oven is now a bright red, but the heat has not yet penetrated to the centre of the bottom cans. The "soak" is accomplished by withdrawing the brick which was left sticking out when the opening was built up, and closing the damper in the flue which leads to the central chimney stack. After "soaking" for 10 or 12 hours, the brick is replaced and the whole oven allowed to cool down. In 48 hours or so after the coal is lit the bricks closing the entrance to the oven are taken down, and the cans are withdrawn and emptied.

Continuous Annealing Ovens.

There is no definite type of continuous annealing oven. They have this in common that only one row of cans is annealed at one time. The fire is at one side only in most cases, and the flames enter the oven through holes or ports in the wall, and leave the oven by similar ports in the opposite wall. Sometimes the flames are led to the flues through holes in the floor of the oven. The length of time the cans are kept in the oven depends upon the size of can used. When the cans are considered to have been thoroughly heated through, the brick-lined door (or doors) is opened, the cans withdrawn, and others placed in the oven.

It is obvious that cans which are allowed to cool in the open do not get so good a chance of producing soft castings as do those which cool within the oven. Neither do they have the important advantage of the thorough "soak" possible in the non-continuous type of oven.

Changed Character of the Castings due to the Annealing.

The object of the annealing is obviously to change the combined carbon into the form of annealing carbon, and thereby make the casting still softer than it was originally. It will be admitted, I think, that with a normal amount of silicon, say, 2 to 2½ per cent., there is certain to be an appreciable amount of combined carbon in the castings. The smaller or thinner the castings are so will the amount of combined carbon be increased. The annealing is required to decompose this compound of iron and carbon into iron plus free carbon. That is what takes place when the annealing is perfect.

Hard Skin on Annealed Castings.

I now come to a consideration of the matter which has caused this Paper to be written and submitted to you. Occasionally it is found that during the course of the annealing the castings have acquired an exceedingly hard, white skin which no tool will touch. The interior of the casting is quite soft, but that is of no use if one cannot get through the hard outer skin. That this is not a small matter is evidenced by the fact that I have seen a 30-ton heap of such castings, none of which could be machined. It is also within my knowledge that this hard skin causes serious loss to several producers of these castings at the present time.

As the outside of the castings could be readily filed before the anneal, and could not possibly be filed after the anneal, it was obvious that the hard skin was acquired during the annealing. It has been suggested to me that this hard skin may be due to oxidation, but there cannot be oxidation of a casting perfectly covered with coke. If the coke sags sufficiently to expose the casting to the flame and gases of the oven, the casting becomes oxidised, but the oxide is red. Neither am I aware of any oxide of a metal which is harder than the metal itself. Neither have I met as yet a white oxide of iron.

A consideration of the whole circumstances brought me to the conclusion that the hard skin was brought into being by the agency of sulphur present in the packing material. This was confirmed by analysis of the small gas coke which was being used for this purpose. The sulphur content approximated 2½ per cent. This sulphur was undoubtedly in greater quantity than what was originally present in the coke. The increased sulphur was obtained from the flames which fill the oven. It is well known that iron and steel take up sulphur from sulphurous flames and gases. Thus, whether cans are covered with lids or not, sulphur can be passed into the charge inside. The fact that the cans, white iron originally, remain white after many times annealing, shows that a cause is constantly operative to keep them white. It has not come within my observation whether cans which are originally grey iron become white under annealing conditions.

The deduction that sulphur was the cause of the trouble was proved to be correct by the hard skin not appearing when the packing material was changed oftener. It did not get the opportunity to become surcharged with sulphur. An additional precaution was to cover the top of the can with lime. This was used as an absorbent for sulphur, and no doubt helped to take it up and hold it. The lime, however, was rather an irritant to the men when packing and emptying cans.

My own experience is greater with coke packings than with cast-iron borings, but from what I have seen of both kinds the white, hard, unmachineable skin is thicker with coke packing than it is with cast-iron borings.

Conclusions.

The conclusions to be drawn are these:—

(1) Non-continuous annealing ovens produce softer castings than do continuous ovens.

(2) The hard skin which occasionally appears on the castings is due to the influence of excessive sulphur contained in the packing material. Also the sulphur originally present in the packing material is augmented during each subsequent heating, and this additional sulphur comes from the fuel used in firing.

(3) Coke dust contains from five to ten times the quantity of sulphur contained in cast-iron borings and thus gets more quickly to the point at which it parts with sulphur to the castings.

(4) If coke dust is used, an addition of lime retards the effect of the sulphur.

(5) Coke dust "sags" during annealing more than cast-iron borings do, and with it warped castings are more common, especially if there has been overheating of the oven.

(6) The packings should be changed often so that the sulphur may not reach the saturation point where it passes the sulphur into the castings.

A Note on Foundry Yields.*

By P. Longmuir, D.Met., and W. H. Robinson.

In the Journal of the Iron and Steel Institute, No. II., 1912, the authors recorded a study of steel-works yields, and the purpose of these studies is explained by the following paragraph from the Paper quoted:—

"Studies of production have as an ultimate object increased efficiency. In some cases efficiency is judged by quantities in others by quality of product. Irrespective of the point of view, before any alterations of method are tried, cut-and-dried data as to existing practice should be obtained."

A similar point of view holds good in foundry practice, for before changes are made, the whole of the facts should be assembled, and dissected. Yield represents the output of good castings, and is perhaps best studied by regular scrutiny of the scrap and defectives produced. However, the range of foundry practice is such that a universal standard cannot possibly be adopted. A normal figure of defective in one class of castings might be abnormal in another class. Generally speaking the majority of castings form parts only of a complete structure, and the work put on each part after leaving the foundry is often of a costly character. Therefore, a high yield in the foundry should not be at the expense of an enhanced finishing cost in the machine shop. This naturally means in the case of a general foundry the grouping of the castings into various classes, and a separate study of each class. An average could, of course, be obtained, but one danger of averages is that they more often conceal than reveal information.

Tables 1 and 2 give the scrap and defective in terms per cent. as ascertained weekly during a period of one year. From these tables the average scrap and defective figures are 4.92 per cent. and 0.21 per cent. respectively. The figures given refer to the output of an iron foundry running almost entirely on one product, viz., ingot moulds for the Bessemer and Siemens (open-hearth) steel plants. They therefore refer to one product and that a speciality

This short note is presented with the one object of placing on record the data given in the table, and it is hoped that it will be the means of eliciting similar data for other types of castings.

Date.		Table 1.	Table 2.
1913.		Per cent. of scrap.	Per cent. of Defective.
January	4	5.13	—
,,	11	5.18	—
,,	18	5.35	—
,,	25	4.35	—
February	1	4.23	—
,,	8	4.21	3.02
,,	15	5.09	—
,,	22	4.29	—
March	1	3.99	—
,,	8	4.51	—
,,	15	4.43	—
,,	22	3.33	—
,,	29	3.48	—
April	5	3.99	—
,,	12	4.32	—
,,	19	4.25	—
,,	26	5.41	—
May	3	5.00	—
,,	10	5.63	—
,,	17	6.98	—
,,	24	6.23	—
,,	31	4.97	—
June	7	4.24	—
,,	14	3.69	—
,,	21	3.80	—
,,	28	4.64	—
July	5	4.82	—
,,	12	5.74	—
,,	19	3.38	—
,,	26	5.07	—
August	2	4.82	—
,,	9	4.49	3.72
,,	16	5.00	—
,,	23	5.49	—
,,	30	5.17	—
September	6	4.78	—
,,	13	4.19	—
,,	20	4.19	—
,,	27	5.82	—
October	4	5.49	—
,,	11	4.70	—
,,	18	4.71	—
,,	25	5.94	—
November	1	5.61	—
,,	8	4.98	—
,,	15	6.12	2.29
,,	22	5.68	—
,,	29	5.03	—
December	6	5.14	0.08
,,	13	6.51	1.97
,,	20	6.25	—
,,	27	6.62	—
Weekly average		4.92	0.21

MAGNETS IN STEEL WORKS.—Mr. H. Von Kramer, in a Paper read before the West of Scotland Iron and Steel Institute, says:—"Few except those who have had actual experience in magnet work are in a position to realise the economies that can be effected in steel works by the magnets. In one instance a 52-in. magnet unloaded 58 tons of pig in 57 minutes, and dispensed with the services of 14 men. In another, the savings effected over hand labour for the filling of charging boxes by means of magnet amounted to £30 per week, or £1,500 per annum, per magnet, and 22 out of the 24 men usually employed were available for other occupations. Incidentally a 42-in. diameter magnet is the smallest size for use in steel works for such purposes. It can only handle 2,200 tons per week, whereas a 52-in. magnet will handle about 3,800 tons per week. It has been found that where such equipments have been installed considerable speeding up of the handling of the materials for feeding the furnaces has been the result, and serious thought has to be given in the immediate future for providing still speedier appliances than the present charging cranes, which, up till lately, have been kept waiting in many cases for a supply of sufficient numbers of filled charging boxes to keep the furnaces going. This delay has been eliminated by utilising magnets to fill the boxes, and an all round speeding up can take place."

* Brief Paper presented before the British Foundrymen's Association: Leicester Conference.

Cores, with Special Reference to Cores of Silica Sand.

By F. C. Pulsford, A.M.Inst.Mech.E.

Some years ago the Company with whom I was engaged experienced considerable difficulty in the removal of core irons from castings of light, hollow form, and it was with some amount of incredulity that my proposal was received to make the cores without irons, rods, or supports of any kind. There did not appear to be any literature on the subject to guide one. Advertisements for foremen with a working knowledge of such method did not yield a satisfactory result, and as my own foreman was somewhat sceptical and unsympathetic, I proceeded alone with my experiments.

A commencement was made with Syracuse core oil from the United States, and sharp sea sand. The advised quantity of core compound was mixed with water, applied to the sea sand and after much turning and mixing of the sand to ensure every grain having a rubbing acquaintance with its neighbour, I commenced on the ramming operation, and duly stoved the core, giving it an over-night drying. The outcome was most unsatisfactory. It was evident that I had used too much muscle but too little brain, with the result that the core was most obstinately glued to the iron box in which it was dried, and was only removed from it by a fettler's hammer and chisel. I would point out here that the important factor of temperature in the drying stove was an unknown quantity. The core stove was of the ordinary coal-fired variety, and had done service for 25 years. It was of the pudding-bag type—the entrance was also the exit—firing also being done from the same end.

I mixed another quantity of sand, using the Syracuse liquid compound, but I added to the sea sand a proportion of spent sand from the fettling shop; one part of old sand to two parts of new sea sand. The core was also more carefully dried, and not having had so much fire was more satisfactory. I proceeded along these lines until I began to collect a few cores which were hung around my office as an evidence that something was being done. Hereabouts a new trouble appeared. The cores were 36 in. long, of oval section, about 3 in. by $\frac{7}{8}$ in., and were continued around the end of the box, giving three legs coupled up together at both ends. The cores contracted a little whilst drying, and as it was necessary to give a slight tap to the core box to loosen the core from its walls, fracture invariably occurred. I patched up a few cores with core gum, and by such means succeeded in obtaining a cast. The result was most satisfactory; the core withstood the pressure of casting, and when the casting cooled off a few taps with a wooden mallet removed the core, leaving a bright glossy interior to the casting, which was one of the problems I had to solve.

Experiments with cores of different sections were still more successful. Core pans were made with all sharp edges worked into an easy radius. A little dry, or parting sand dusted on the face of the core pans solved the difficulty of both contraction and adherence. Such results, however, were not readily attained. Numerous experiments were made with several American liquid compounds, also linseed oil, cotton-seed oil, and fish oil, but the most satisfactory result was secured by using the production of the C. E. Mills Company, of United States of America. It was a compound which more nearly resembled linseed oil than any of the others I had used. Patent gums, resin, pea flour, and many other compositions were brought into requisition, but the C. E. Mills oil binder was the only one that gave all-round workable results. Its chief drawback was its high cost.

A visit to the United States confirmed the idea that I was proceeding on the right lines, and on returning I continued on the old lines with the Mills compound until eventually I got hold of a foreman who had had some Yankee experience. He was young and enthusiastic, and so fell in with my ideas, and with his sympathetic assistance the result I had anticipated seemed assured, and eventually became an accomplished fact. With the foreman's co-operation these special cores, without rods or supports of any kind, were further cheapened by the introduction of cold-drawn cod oil as a substitute for the Mills compound, and also by the addition of black floor sand. Beeston Rock sand, and Bedford pit sand were also introduced instead of Sutton sea sand, which we were then using, until we were able to produce all our intricate cores without rods or supports, or with the minimum support where experience suggested such was advisable. The outcome of these re-arrangements was very satisfactory, for we were enabled to improve the fineness on the interior of the castings, at the same time to decrease the cost of the cores and also to obtain the oil from our home markets, which was an advantage, as it enabled us to carry less stock.

My experiments with these cores lead me to the following as being the best mode of procedure :—

Mixing.

Care must be taken with the mixing. It is preferable to well mix the old floor sand, the Beeston, Bedford and spent sand thoroughly whilst in a dry state. The mixing is best done by hand. When using a mixer of the centrifugal type the heavier grains of sand separate from the lighter particles at different points and an unequal mixture results; the coarse grains being at the extreme edge of the mixture, as will be well understood. After the sand has been thus thoroughly mixed by hand, the oil should be added. If it is necessary to add water it is best to add it to the oil and well mix until emulsified. After thoroughly turning over the sand and oil mixture a few times it should be passed through a $\frac{1}{4}$ in. mesh riddle.

Ramming.

Don't ram hard. A dolly rammer is all that is necessary unless the box is too small for such a tool. In any case, whatever core is being made the sand only requires to be tightly tucked home.

Patching and Venting.

Free vents are essential as a lot of gases have to escape when pouring. With oil-sand cores no patching nor external venting is necessary. Coke breeze, hay, etc., and all the ramifications a coremaker needs to secure "a good job" are dispensed with; the time required to iron weak parts, the difficulty of ramming around these and the cost of irons, may be eliminated from much of the work in the core shop by the adoption of oil-sand cores.

The method is, of course, more ideal where repetition work is a speciality, but it can with advantage be adopted for much of the jobbing work passing through our foundries every day. The method requires perseverance to achieve success, also the breaking down of foolish opposition, which usually emanates from the ignorant or prejudiced, or perhaps from the person who is content to do as his father did before him, considering that way good enough. Objections have been raised to the use of oil-sand cores on account of the odour when casting. When pouring off, a good deal of gas is generated, but a reasonably ventilated foundry is able to deal successfully with the fumes. No evil effects attend the form the interior cleaning, I can with confidence recommend the method to the careful consideration of foundrymen.

Green-Sand Cores.

During last year I introduced into our foundry the manufacture of green-sand cores for bends, tees, and straight pipes. Thousands of tons of metal are, of course, being poured every year in various districts of the country with green-sand cores, but here we are encompassed with prejudice. Needless to say, the introduction proved successful here, and as there is not anything new in it, I claim no achievement. I merely mention the fact as an instance of what can be done by perseverance and determination to succeed, but this must be backed by some knowledge of the ironfounder's art; an intelligent conception of its possibilities and the removal of prejudice, by which means only can success be assured.

CUPOLA LININGS.—In a memorandum contributed to the "Proceedings of the American Foundrymen's Association," Mr. W. A. Griswold gives a record of a cupola lining which is of interest to foundrymen,

FIG. 1.—CORES FOR CASTING IN FIG. 2; OUTER DIAMETER 8 IN., INNER DIAMETER 3½ IN., WALLS OF CORE ¼ IN THICK, DEPTH 6 IN.

FIG. 2.—SECTION OF CASTING, SHOWING INNER AND OUTER RINGS OF CORED PART.

men who work this process. We have been busy with it for eleven years, and the men have no fault to find.

Drying.

Experience has shown that the term drying is not suitable. The process is better termed baking. Care must be exercised at this stage, otherwise a whole oven-full of cores may be scrapped; for after a certain temperature the cohesion of the sand particles diminishes and the cores become useless. We have long since used a recording pyrometer of the Bristol type, and we find if the cores are baked at about 400 deg. F., satisfactory results are obtained. These cores will remain good for days after baking, even if removed from the stove, as they do not absorb moisture like the usual loam-sand core.

Core Pans or Shells.

If the job on hand is not repetition work, oil-sand cores may still be used by the judicious adoption of frames which will surround the core. If such a frame is being used, ordinary damp spent floor sand can be packed around the core and well secured by pressure, but this pressure must not be enough to distort the shape of the core, which is very fragile and practically without bond. The cores should be covered with an ordinary carrying plate, turned over and out of the core box just as would be done with ordinary cores.

On account of the economy, the facility of production, and the ease with which the fettlers can per-

as an instance of the length of life attainable when the bricks are given proper treatment. The fire-bricks were laid without any clay mortar whatever. They were placed to within ¾ in. of the shell, and the space thus left filled with parting sand. Care was taken to have the joints as small as could be made. Charging the cupola was carried on with the ordinary care that should be given this work. The blast pressure ran from 12 to 15 ounces, the melting rate was from 14½ to 16 tons per hour, the cupola diameter inside the lining 66 in., and the melting ratio from 8.1 to 8.4 lbs. of iron per pound of coke. From the above figures it will be seen that full returns were expected from the cupola, and the lining was not "nursed" by any means. The lining was put in on June 2, 1912, and no new bricks were put in until the cupola was again relined on October 19, 1913, it being deemed inadvisable to take any chances. After the lining was out, however, it was seen that the cupola could have been safely run for another hundred heats. The author points out that where foundrymen have to reline the melting zone frequently, not to speak of the rest of the cupola lining, a little attention to the work in the first place—the exclusion of materials allowing fluxing action between the bricks themselves, careful chipping to remove slag that will continue to eat in further with every melt and at the same time allow any daubing put on to slip off the moment the slag behind becomes soft—will result in maintaining the integrity of the lining for a surprising tonnage and length of time.

Considerations in the Design and Operation of the Foundry Cupola.*

E. L. Rhead, M.Sc.Tech., F.I.C.†

In the design of a piece of apparatus for any given purpose, it is first necessary to study the conditions under which it will be used and the variations in conditions possible as the result of accidental and functional changes, and also its connection with and dependence on other appliances with which it will have to act in conjunction, and by which its efficiency will be largely affected. It will be necessary to consider its position in the scheme, whether it occupies a primary or subsidiary place, and in the former case to build the scheme round it, or in the latter to build it in, having first shaped it in size and form for the position and purpose intended.

In melting iron for the foundry, the cupola holds the position of the first importance, and its behaviour will determine to a large extent the success attained not only in this particular department of foundry work, but also in the general success.

The object aimed at in the successful operation of a cupola is to provide a supply of molten iron sufficiently hot for the purpose in hand as rapidly or as regularly as possible, as the case may be, with the minimum of cost in labour, fuel and attention—a reliable appliance whose working can be reduced almost to a standard, and the results relied on with certainty, so long as working conditions do not depart from the normal to a greater extent than is likely to occur from the usual minor accidental circumstance of daily work.

It may be called upon to supply, during the same run, metal of different qualities for different purposes, or it may run for long periods on material of the same character. Special features may be necessary in the latter case, but in all circumstances the primary object is to secure rapid, hot and economical melting.

Conditions for Hot and Economical Melting.

In order to do this it will be necessary first to attain a temperature high enough to melt and superheat the metal sufficiently to enable the mould to be filled while yet the metal retains all its constituents in perfect solution, so that cooling and solidification can proceed regularly. Second, to generate sufficient heat to melt the metal and raise its temperature to the desired limit with as little fuel as possible. The minimum amount of heat required for these purposes is a perfectly definite amount, depending only on the melting point, and the specific and latent heat of the metal.

In this connection it must be borne in mind that the burning of a given fuel can only generate a certain quantity of heat per unit weight consumed under the best possible conditions. This depends on its composition only. Whether this amount is generated depends on how completely the fuel is burnt. Carbon, it will be remembered, burns in two stages—to the monoxide CO, and the dioxide CO_2. The maximum amount of heat is produced by the latter change, but instead of the former change producing a half of the amount, it only produces something less than one-third of the total. It is therefore obvious that the combustion should be made as complete as possible. Complete combustion can only be attained when there is a sufficient excess of air to furnish oxygen. If in the burning of coke or other carbonaceous fuels, there is a *local* excess of oxygen, carbon dioxide may be formed, but if that gas comes into contact with carbon at a sufficiently high temperature—say, above redness—the carbon deprives it of half its oxygen and reduces it to a carbon monoxide with an absorption of heat. Both factors must be reckoned with, viz., temperature and contact. If the temperature is too low to furnish the heat for the reduction,

$$C + O_2 = CO_2 + 96{,}960 \text{ heat units.}$$
$$C + O = CO + 29{,}676 \text{ ,, ,,}$$
$$CO + O = CO_2 + 67{,}284 \text{ ,, ,,}$$
$$CO_2 + C = 2CO - 37{,}608 \text{ ,, ,,}$$

it will not take place, and if contact of the gas with the carbon does not occur it will remain unreduced.

These considerations are of the greatest importance in dealing with the blast, its quantity, distribution and pressure, and also with the rapidity of the gas current passing through the cupola, the size of coke and its quality. Any condition making an increase in the amount of carbon dioxide in the gases passing from the furnace must result from an increased development of heat in the cupola from the coke burnt. It must not be overlooked that the carbon monoxide will, *if still hot enough* to ignite, burn in an excess of air and produce carbon dioxide as shown above, with the generation of much heat.

Of equal importance is the economical application of the heat generated. In ordinary cases, heat is only communicated to one body by another by contact or by radiation. In the case of gases this occurs only by actual contact, as gases possess little radiating power, so that in a cupola heating of the metal and other materials must result from (*a*) actual contact with incandescent coke; (*b*) heat radiated from the surrounding coke—but only by the exposed coke surface—if two pieces of glowing coke are one behind the other, radiant heat only reaches the metal from the surface immediately facing it; (*c*) by heat abstracted from hot gases impinging on the surface of the metal. Since the final product of the burning is gaseous, the part played by the gases is of primary importance. By far the greater part of the heat generated in the furnace is first taken up by the gases and by them distributed in the furnace. Consequently any consideration that influences the manner of distribution or the completeness of the contact of the gases with the solid materials in the furnace will produce its due effect on the working of the cupola, irregular distribution leading to imperfect contact and irregular heating, with incomplete cooling of the gases and loss of heat. Incidentally, if the cooling of the gases be not properly affected, the region of high temperature extends higher in the furnace, either generally or locally, and in some cases the lining of the furnace will suffer.

* Paper read before the British Foundrymen's Association; Leicester Conference.

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The Means Necessary to Secure the Conditions.

It has been already pointed out that a certain quantity of useful heat is required to melt the metal and slag in the cupola, and that a certain quantity will be wasted or lost in various ways. That heat may be considered lost which is not transferred to the metal and slag. These losses comprise (*a*) loss by radiation from the casing of the furnace; (*b*) sensible heat carried away by the hot gases from the throat; (*c*) undeveloped heat represented by the carbon monoxide in the gases.

To a greater or less extent these are unavoidable, and the cupola will be most efficient in which these losses are reduced to a minimum. In ordinary circumstances the whole of the heat is derived from active combustion, none being carried in mechanically by using a hot blast as in iron-smelting blast furnaces. A brief glance at these losses will point out some useful conclusions.

Loss by radiation will depend on the temperature of the casing and that on the rate at which heat is conducted to it from the hot interior by the lining. The thickness of the lining and its conductivity will thus enter into the consideration. The latter varies comparatively little for firebrick, but the thickness of the lining will, of course, have an effect.

The extent of the surface of the casing, compared with the sectional area of the furnace, has a large influence. As the area and capacity per unit of height increase with the *square* of the diameter and the circumference with the diameter the proportion of surface to capacity rapidly diminishes.

Diameter of cupola.	Sectional area.	Circumference.	Surface. Cubic capacity.	Cubic capacity feet. Area of surface.
1	0.7854	3.1416	4	0.25
2	3.1416	6.2832	2	0.5
3	7.0686	9.4242	1.3	0.75

Obviously the loss of heat from this cause must be less in the case of wider cupolas than in narrow ones, and greater economy must result. The only practicable means of preventing this loss—lagging the cupola is out of the question—is by circulating the air blast round the cupola and carrying the heat thus taken up back into the cupola, so that so far as the portion of the cupola treated is concerned the loss of heat is avoided. Obviously, any cooling of the metal reservoir is out of the question, as the circulation of air round it would remove heat more rapidly than it would be dissipated by ordinary radiation. Clearly, also, the largest loss will occur in the hottest part of the furnace—the melting zone and immediately below it.

Incidentally, any cooling that may be effected will tend to protect the lining of this most important part of the furnace and maintain the lines of the furnace interior.

Several makers of furnaces, either designedly or from convenience of blast supply, circulate the air round the furnace—the ordinary outside air belt, as used in the Thwaites "Rapid," Allday & Onions, and Colliau & Whiting cupolas has this effect. Numerous others may be mentioned. The air at the tuyere is considerably hotter than the atmosphere.

In some cupolas the air belt is constructed inside the casing, thus reducing the thickness of the lining and increasing the heating effect on the blast. The "Jumbo" furnace and the "Calumet" may be cited as instances. Reference may also be here made to casings placed in the upper part of the furnace, avowedly for the purpose of heating the air blast, as in Higham's cupola. To avoid undue importance being attached to this point, the value of the saving effected may be stated in terms.

A hundredweight of coke containing 90 per cent. carbon requires approximately 15,000 cub. ft. of air at the ordinary pressure for its complete combustion, allowing for no excess, equal to 12 times its own weight. This is assuming its conversion to CO_2 (it would produce the same volume of gas with a weight equal to 13 times that of the carbon burnt). This, if heated 1 deg. F., would contain 328 B.T.U., or if heated 100 deg. F., 32,800 B.T.U., less heat than would be generated by the complete combustion of 2.5 lbs. of the coke. Its effect on the working of the cupola, however, is greater than the smallness of the amount would imply. The chilling effect of the air as it enters the cupola is reduced and there is less tendency to form obstructions. A better heat distribution is consequently assured.

Sensible Heat in Gases Leaving the Throat of Furnace.

There is little probability of the gases emerging from an ordinary cupola being cooled below 500 deg. F., and they usually reach 650-700 deg. or even higher. It follows that at the former figure the loss from this cause, as shown above, would be equal to a little less than 12.5 lbs. of coke or 12 per cent. of the weight of coke burnt, calculated on the burning of the carbon to carbon dioxide. If calculated on carbon monoxide the percentage is nearly 18, owing to the smaller amount of heat generated, although the weight of gases is only a little more than half ($\frac{7}{13}$) for the same weight of fuel burnt.

If two-thirds of the carbon burns to CO_2 and one-third to CO, the loss is approximately 14 per cent. The actual loss occasionally is more than double this amount as the temperature of the escaping gases is often 1,000 deg. F., or even higher, and the proportion of CO greater. Further, the quantity of air supplied is in excess. The figures given are based on the minimum quantity.

Since the initial temperature of the gases, as formed in the combustion zone, is fixed by the temperature of melting required for teeming purposes, it follows that this will depend on the extent of the subsequent cooling of the gases. In this connection the amount of the gases as well as the temperature must be considered.

Any modification that will cause a reduction in the temperature of the escaping gases and in their amount will tend to economical working.

Since gases only give up their heat by contact with solids, and the rate of exchange is proportional to the difference of temperature between the bodies in contact, in a cupola of any given capacity the smaller the amount of gas to be dealt with the greater the extent to which its temperature will be lowered.

Undeveloped Heat Represented by Carbon Monoxide in the Gases.

As pointed out, carbon in burning to the monoxide generates less than a third of the total heat of combustion. The loss of heat due to this cause is obvious. Its presence may be due to an insufficient air supply; bad distribution owing to certain areas of the furnace not receiving their proper quota while others receive an excess; or to cooling down of the carbon monoxide thus generated below the ignition point before it is mixed with the air intended to produce complete combustion. In any case, to generate the heat necessary to carry on the melting, an increased amount of coke must be burnt. Its presence in a greater or less quantity cannot be avoided.

Economy v. Convenience.

So far attention has been devoted solely to the economical aspect, because if economy, represented

by the useful application of the heat produced, be attained, the accidental difficulties usually encountered will be minimised or disappear altogether.

Height.

The relation of the height to diameter will determine largely the number of contacts which the gases in the ascending current make with the solid matter of the charge and thus the extent of the cooling effect it produces. All the heat abstracted will be carried downwards towards the melting zone and reduce the amount it will have to take up in that region, so that not only economy will be secured but the time occupied in absorbing it will be less; the melting will be quicker and the metal will be exposed for a shorter time to the action of the blast with consequent less alteration in the calculated composition of the metal.

In comparing narrow and tall structures with others wider and lower it must be noted that for the same volumes of gases and weights of charge the velocity of the gas current in the narrower furnace reduces the time of each individual contact but increases the number. In the wider, the time of contact is increased, but the number is reduced. That the former condition is most efficient will be seen when it is remembered that gases are the worst conductors of heat, and when contact occurs the film in immediate contact has its temperature lowered by giving up heat, and that the heat from the remainder of the gas can only be transmitted through the cooled film, thus slowing down the rate of transference. It is due to this very largely that even when burning larger amounts of fuel the old-fashioned low cupolas do not produce metal hot and fluid enough for the lightest type of castings. In some of the old cupolas, with a total height of 7 to 8 ft. and tuyeres 22 to 26 in. above the bottom, the top of the bed frequently extended 15 to 18 in. above the tuyeres and thus left only 3 to 4 ft. for the reception of the charge.

In modern cupolas a ratio of height to diameter of about 5 to 1 gives satisfactory results, as affording the greatest economy, without unduly increasing costs of construction and handling of stock. A further point is the possibility of the lodgment of the charge, especially in small cupolas, and the necessity of using bars to dislodge it. If the obstruction is low down the difficulty of removal becomes too great if the charging hole is high.. A ratio of 4 to 1 is often maintained on this account.

The efficient concentration of the heat will operate in every direction; less fuel burnt means also less air necessary, less gas to cool, with better abstraction of heat; and less power for blowing purposes and more regular working of the furnace.

Tuyere Area.

The rate at which the fuel is burnt and heat generated, which determines the melting rate in the cupola, is dependent on the quantity of air supplied in an efficient manner. In the older cupolas the tuyere area was far too small, and very curious conclusions were frequently arrived at. An increase of pressure produced better results. This was ascribed to the necessity of securing penetration of the charge by the blast, whereas its effect was mainly due to the increased amount of air so supplied, as well as its greater penetration. It will be seen that if a tuyere opening into the larger chamber of a cupola is incapable at a suitable pressure of supplying sufficient air to extend over its superficial area, if the pressure be too low its upward movement will commence near the sides of the chamber, leaving the middle unaffected, but with a larger volume its effect will penetrate more deeply into the mass, the resistance offered to its lateral as compared with its vertical movement determining its relative movement in the two directions. The increase in pressure will, by driving it forward, overcome the natural tendency of the air to rise due to becoming heated, and the less close packing of the material in contact with the furnace wall.

The best results must ensue when an equal quantity of gas is diffused over the whole sectional area of the furnace and rising regularly through the stock in the furnace. Any tendency of the air to creep up the sides in large volume will, unless the bed is deep, produce cooling and a tendency to hanging of the charge.

It follows, since a definite amount of air is required to burn coke used in melting, that for the admission of a given quantity of air at a given pressure, a certain tuyere area is necessary; that the minimum pressure necessary to secure the uniform diffusion of the gases will vary with the diameter of the furnace; and the rate of supply must vary with the depth of the stock above the tuyeres, since that will determine the frequency and period of contacts.

From the latter conclusion it would appear that for every cupola, in order to get the most economical results, there would be a different ratio, but if the height is sufficient to secure the cooling of the gases, a further increase has little or no effect unless it is such as to materially increase the resistance offered to the free passage of the gases through the contents of the furnace. It may, therefore, be eliminated and its application limited to those older and lower furnaces now rapidly disappearing.

The consideration, however, affords thought on the value of adjustable tuyere areas such as are provided by reducing tuyeres or even by cupolas having upper rows provided with doors for closing them when necessary. The provision of adjustable tuyeres is of advantage on experimental cupolas or on those dealing with material liable to great fluctuations in size and tendency to pack in the cupola, or where great fluctuations in the blower are likely to occur through lack of power, etc.; but on those running on uniform material under constant conditions adjustable tuyeres afford no advantages other than those of emergency.

The other factor controlling tuyere area is the shape. The volume passed by tuyeres of equal area but of different shapes, will vary with the friction encountered, and as

$$p\,a = K\,S\,v^2$$

where p = pressure, a = area in sq. ft., S = area of surface, v = velocity, and K = coefficient of friction. It follows that the friction will vary with the size of bounding surface, whether round, square, triangular or flat, and an increase in area in these proportions will be necessary in passing from one form to another if equal amounts of air are to be delivered under the same conditions of pressure.

The results of experiments carried out to determine the best ratio of tuyere area to sectional area must consequently vary.

Bellamy arrived at a ratio of $\frac{1}{19.2}$. The following experimental results representing the conditions finally decided on may be compared :—

	No. 1.	No. 2.
Diameter at tuyeres.. ..	32.5 ins.	47.0 ins.
Diameter, widest part ..	40.0 ,,	61.0 ,,
Diameter of tuyeres ..	4.5 ,,	5.25 ,,
No. of tuyeres	3 ,,	4 ,,
Height tuyeres to stage ..	96 ,,	84 ,,
Height bottom to tuyeres ..	28 ,,	28 ,,
Blast pressure	20 ,,	30 ,,
Sectional area at tuyeres ..	17.4 ,,	20 ,,
Tuyere area	1 ,,	1 ,,
Volume of air per square inch per second	1.2	1.44
Area fed per square inch tuyere area..	14.5	14

The smaller cupola was melting from 2.5 to 3 tons per hour and the larger 5 tons, with a coke consumption (without bed charge) of 1 lb. coke to 7 lbs. iron. Under the conditions of working this was good. It will be observed that the average ratio for the two, viz., 1 : 18.7, compares favourably with the former determination. Neither of the cupolas was as high as it would be advisable to make them if new ones were being installed, and in that case probably a nearer approach to the figures might have been made.

In existing cupolas the throttling of the blast by tuyeres too small for the purpose is often a source of delay and loss. On the other hand too large a tuyere reduces the blast pressure below the limit of efficiency, or if the pressure be increased admits too much air.

Number, Shape and Position of Tuyeres.

Few points in connection with cupola construction have received more attention in recent years. Each inventor has endeavoured to secure the most perfect distribution and complete combustion. Apart from the question of pressure, the position of the tuyeres exerts a great influence and the advantage of using a number of tuyeres is so fully recognised as to require no comment. Special shapes may be divided and classified as elongated deep tuyeres, flat tuyeres, or a combination of the two. The reducing tuyeres of the Truesdale and Laurence type, as well as vertical slot tuyeres, belong to the first class. In the second class, sheet blast, oval, expanded, Blakeney, MacKenzie, Whiting, and many others are included, while the triangular, reversed T and the horizontal and vertical slot combination belong to the third class. Some of these, like the Blakeney, are intended to give a definite direction—more or less important—to the blast, but it is first necessary to consider them as mere air inlets.

In tuyeres of the first and third types, the objects aimed at are to supply air in such a manner as to secure complete combustion and to prevent bridging of the furnace, the upward extension of the tuyere being intended to supply air to consume the CO generated by the air entering by the lower portion, which in many cases is wider and supplies the bulk of the air. How far this is possible is very doubtful. The conditions previously considered will show that at the ignition point of carbon monoxide, coke itself would burn in a supply of air, and the heat produced by the carbon monoxide burning would increase the temperature, thus making it burn more readily. Further, the upward extension of the tuyere—some of them are 12 in. high, and in a few cases 16 to 20 in. high—would mean an extension of the coke bed above that level and a correspondingly higher position of the melting zone, with a reduction in the effective depth of descending charge cooling the gases. The successful results obtained by some of these arrangements must be attributed to a better supply of air and the greater number of tuyeres giving a better horizontal distribution of blast, rather than to their upward extension.

The advantages of flat tuyeres lies in the fact that to secure an adequate tuyere area they must extend round a greater part of the circumference and secure a better and more even distribution of air. The nearer they approach to a continuous slot the more perfect this becomes. The consequent narrowing of the aperture brings the zone of active combustion and the melting zone lower in the furnace, thus tending to economy. Whether any specialised form has distinct advantages will depend on the blast pressure. The pressure of blast entering the furnace by an expanded tuyere widening towards the furnace will be less than the air at the same pressure be supplied by a straight slot or by the one which is contracted towards the interior of the furnace.

Position of Tuyeres.

Lowering the position of the tuyeres and diminishing the thickness of the coke bed increases the effective height of the cupola and tends to economy.

The height of the tuyeres, as the main factor in determining the position of the melting zone, has also a marked influence on the practical working of the cupola, such as its freedom from hanging and bridging. Other factors that enter into the consideration are the pressure and volume of blast, as they affect the amount and upward velocity of the air current. Increased quantities absorb more heat from the material immediately in front of the tuyere and produce a greater cooling effect. Whether this causes the hottest zone to be somewhat raised or not will be influenced by the actual amount blown in. If this exceeds the required amount or the amount that can be usefully employed in combustion under the working conditions, the zone will be raised, but if the increase does not exceed this quantity then the amount of fuel usefully burnt in the region of the tuyere will be increased, the amount of heat generated greater, more rapid melting of the stock, accompanied by a quicker descent of the charge, with a corresponding greater cooling effect on the gases, and greater concentration of heat in the melting zone with the lowering of that region.

There is, therefore, considerable justification for the provision in cupolas of means of adjustment of the tuyere position to suit all the exigencies of any particular case, but once that position has been found, unless some departure is made from the existing conditions, there does not appear to be any further need for it.

In actual working, pressure and volume of air should be maintained as nearly constant as possible and the shape of the furnace should not be altered or its capacity increased or diminished by changing the thickness of the linings, as sometimes advocated, nor should the daubing up of the walls be so carried out as to alter the diameter by giving a smaller diameter at the beginning of its use to allow of greater wear and tear before daubing up again—a variation sometimes amounting to 4 in. Such a variation on a 30-in. cupola means a difference of 15 per cent. on the sectional area of the cupola.

The distribution of the tuyeres round the cupola includes the consideration of the employment of one or more rows. From the considerations laid down at the commencement, the following deductions may be made :—

Since the concentration of the heat low down in the furnace gives better facilities for cooling the gases, and this can be best effected by placing the tuyeres low down, if it be possible to supply a sufficient amount of air and properly distribute it by a single row of tuyeres, the best results, economical and practical, will be secured. But where a greater amount than can be properly distributed by a single row is employed, in order to secure rapid melting, two or more rows may yield better results. The advantage, if any, that is secured results from increasing the *volume of the furnace* in which active combustion is proceeding, allowing a greater amount of coke to be burnt and more heat generated. It necessitates increasing the depth of the coke bed to compensate for a raising of the level of the combustion zone. The extent to which it is effective or otherwise will de-

pend on the character and disposition of the coke in front of the tuyeres. If the bed be more readily penetrated, distribution will be easy and a single row of tuyeres effective. When a double or triple row of tuyeres is used, the disadvantages alluded to above may be minimised by giving the upper rows such a downward inclination as will cause a concentration of the blast on a lower plane. How far this will be effective is influenced by the pressure and by the fuel, for it must be remembered that the penetration and distribution are not such as would obtain in an empty furnace.

It will be inferred from the foregoing that where more than one row of tuyeres is necessary, the distance between the rows should be as short as possible.

Upper rows of tuyeres are sometimes a source of trouble. If a lump of cold iron gets in front, bridging may quickly commence, and from the position of such tuyeres it is obviously more likely to occur, especially when the minimum coke charges are being employed. Hence the provision made in many cases of doors or dampers to the top tuyeres, at least, and the permanent closing of them by many foundrymen.

One advantage of a double row of tuyeres is that it provides the foundryman with a cupola having some reserve in its melting powers. A cupola of adequate diameter with adjustable tuyeres and an additional upper row which may be closed at will, may be used as a single-row furnace with a thick lining for general purposes, but on occasion the increased thickness of lining may be removed and the additional tuyeres called upon. This would necessitate the existence of sufficient blowing facilities to meet the increased demand for greater volumes and pressures of blast.

Shape of Furnace.

Consideration of this feature will be restricted to the internal lines of the furnace, and the question of drop bottoms and other points mainly connected with facility of handling will be omitted except where they have a definite bearing on the efficiency of working. All makes of cupola may on this consideration be classed under three headings :—

(1) Straight shaft cupolas, with or without enlarged bottom reservoirs.

(2) Cupolas contracted in the region of the tuyeres, (*a*) with straight shafts; (*b*) expanded shafts.

(3) Cupolas with shafts tapering upwards.

The advantages or otherwise of these forms must be looked at from two points of view. Ease in handling, as well as economy, is important, and the shape probably exerts a greater influence on this than on the economy of melting.

Bearing in mind the modern method of charging and working a cupola, viz., the charging of the fuel and metal in distinct layers so adjusted that the top of the bed coincides with the top of the melting zone, as indicated by the effect produced on the lining, the charges being so adjusted that as the last part of a charge melts at the level of the lowest point of the melting zone and the next layer of coke just fills the zone so that the following charge of metal begins to melt at the top of the melting zone, it will be seen that success and regular working depend on the uniform descent of the materials, and if uniform distribution of blast be secured, a straight wall would ensure this.

Any tendency of the blast to pass up the sides of the furnace as the result of the looser packing of the material in contact with it would lead to greater cooling immediately above the tuyeres, although a greater amount of combustion might result at a higher point in virtue of the increased amount of air traversing that part of the furnace. In that event, the melting zone would be raised at the sides and lowered in the centre of the furnace, while the gases at the sides would be less efficiently cooled and the metal would not be preheated to the same extent. A slight increase in the thickness of the fuel layer at the sides, so as to provide a somewhat larger amount to correspond with the increased quantity of air, would prevent it from burning away too rapidly and permitting the unmelted metal or slag to come down so far as to meet the cooling effect of the blast and getting in front of the tuyeres, thus setting up bridging. The practice often followed of heaping the metal to a greater extent in the centre of the furnace provides this disposition of the materials, and no obstruction is offered to the regular descent of the charges.

In cupolas contracted in the region of the tuyeres, the object of getting the blast to the centre of the cupola, often given as the ostensible reason for doing it, is fulfilled, but, as previously shown, this can be effected by properly adjusting the blast pressure to the diameter of the furnace, and any real advantage must be looked for in another direction. Since the value of any contraction, except possibly in cupolas of the largest size, in supporting the weight of the contents may be passed over as unimportant, the only benefit possible would be that derived from securing a better distribution of the hot gases from the combustion region among the stock in the upper part of the furnace. It undoubtedly does this by delivering the gases into the centre of the furnace and preventing them escaping up the sides. The early success of Ireland's cupola must be, in the author's opinion, attributed to both these causes. It must be remembered, however, that such narrowing of the cupola is practically reducing the cupola to one of the narrower dimensions, as all combustion and melting must be done in the contracted area.

Further, any contraction that is made must extend above the uppermost limit of the melting zone or the obstruction it offers (especially in those having no slope but simply built out in the brickwork) would be likely to lead to bridging by the melting material forming accretions whenever a slight or momentary cooling takes place. How far this is liable to occur will be familiar to those who have studied the effects of the linings getting out of shape, and confirms the statement made by Kirk that in his experience with the MacKenzie cupola "slag and cinder adhere to the lining over the tuyeres and become very hard and difficult to remove, and if care be not taken to remove them after every heat, it soon builds out, which reduces the melting capacity and increases the tendency to bridge and hang up."

In cupolas with shafts tapering upwards, a further condition is involved. That the descent of the material is assured is palpable, but an appreciable contraction would have the effect of permitting the hot gases to come into more direct contact with the sides of the upper part and produce a greater heating effect on the walls. This, however, would in most cases be slight. The author is acquainted with only one cupola in which this is carried into practice—the water-jacketed cupola of Gmelin, in which the radius increases by the thickness of the plates at each joint from the top downwards. In this cupola the effect of the greater heating of the sides cannot be gauged, as the circulating water prevents any undue heating. As stated previously, the consideration of drop bottoms, receivers and other special arrangements, was not included in the matters it was the author's intention to discuss.

Plaster of Paris in Foundry Work.*

By C. Heggie.

[NOTE.—The author having already dealt with this subject at length in our columns (see issue of January, 1914), an abstract only is given herewith.]

The writer is aware that neither in Great Britain nor America are the possibilities of plaster-of-Paris for patterns sufficiently appreciated, and this Paper is given with the hope that it may lead to the introduction of this useful material in many shops, especially of the engineering class, where its advantages have been chiefly ignored.

I have made several experiments on the strength of plaster in relation to the proportions of water and plaster used in mixing, but, of course, their only value is as comparative tests. The method used was that of pushing over the sharp edge of an iron plate a section of plaster and finding the length of the part broken off by measuring the remaining piece. Two sections used were ¾ in. by 5/32 in. and 1 in. by ¼ in. To decrease the length of the pieces broken off so that shorter test pieces could be used, a weight was suspended from one end, weighing in the first case ¼ lb., and in the second ½ lb. The following are the figures:—

Proportions of Water and Plaster by Weight.

Hours.	W. P. 8 6	W. P. 8 8	W. P. 8 10	W. P. 8 11	W. P. 8 12
	Section ¾" × 5/32" (Weight ¼ lb.)				
2	2 in.	3¼in.	4¼in.	—	5¼in.
26	3¼in.	6¼in.	7¼in.	—	9¼in.
	Section 1" × ¼" (Weight ½ lb).				
2	3¼in.	5in.	7in.	7¼in.	8¼in.
26	3in.	4¾in.	6¾in.	7¼in.	8¼in.
70	—	—	—	12in.	—
200	—	—	12in.	—	—
	Carelessly Mixed and Overworked Plaster.				
2	—	—	—	—	4¼in.
26	—	—	—	—	4¼in.
	Wrongly Mixed Plaster.				
2	—	—	—	—	6¼in.
	With Lime.				
2	—	5¼in.	7¼in.	9¼in.	8¼in.
26	—	5¼in.	7¼in.	9¼in.	9¼in.
96	—	—	—	10¼in.	—
120	—	—	—	11in.	—
	With Alum.				
2	—	4¼in.	5¼in.	—	8in.
26	—	3¼in.	5¼in.	—	6¼in.
200	—	—	—	—	9¼in.

Attention may be drawn to the tests of plaster purposely mixed wrongly. The proportions are—water 8, plaster 12, which should give good results. The figures, however, are for two hours 4½ in., and for 26 hours 4¼ in., as against 8⅛ in. and 8⅛ in. respectively with correctly-mixed material. Further, all the test pieces, with varying proportions of water and plaster but all carefully mixed, were quite straight, whilst the pieces broken from the carelessly-mixed bar were warped and bent. Though these figures may be of no real value in themselves, they indicate that correct mixing and the proper proportions of the materials used are essential to a sound job. It is also essential with plaster work that the job be done quickly, and where possible with one mixing of plaster, as continual mixings and an excessive use of the template make the patterns weak and "rotten."

Many straight patterns made as described are not complete in themselves, castings being made from them in some of the white-metal alloys. These are finished by filing and chasing, and soldered together to form the complete pattern. In many cases, however, the "plasters" may be assembled to form the

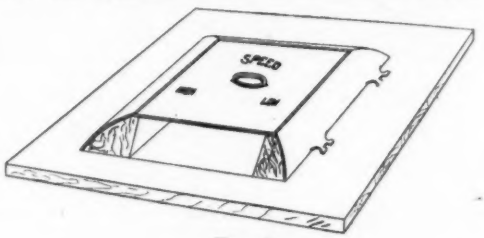


FIG. 1.

pattern, as shown in Fig. 1. The panel would be treated separately and, if plain, would be scraped out by the moulder. The door, if suitable, could be run in one piece by having four guide strips on the board, or by using the edges of the board as guides.

Figs. 2 and 3 show typical instances of circular patterns worked from a centre pivot. The production of such patterns in plaster is simple and cheap, and a regular thickness is assured, while to build and turn up the same in wood takes a fair amount of time and more expense in material. In reference to this, it may be mentioned that fine plaster in the form of patterns cost about one-half

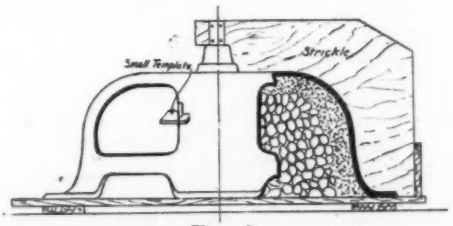


FIG. 2.

that of the best yellow pine, for the same number of cubic inches. Of course, as a rule, there is the initial expense of an iron pattern which, however, has many decided advantages over one of wood, one of the greatest disadvantages of the latter being its liability to warp. In some patterns of the above type a bead, or a fitting strip may be wanted round the edge of the holes. This is done by a small template which takes its bearing on the block and edge of holes as shown.

In cases like these, where large blocks are required, it is usual to reduce the weight by packing up with material of lower density. Wood lagging may be used, but its tendency to swell and warp when in contact with the plaster makes it undesirable, and

* Paper read before the British Foundrymen's Association Leicester Conference.

even where the wood is thoroughly soaked before using, there is still the risk of the block becoming warped when the wood dries. The most common practice is to use coke. The following remarks apply in a general way to the patterns in Figs. 2 and 3. The coke is built up so that a suitable thickness, say ¾ in., of plaster can be run on the top of it. A wood centre block is screwed to the board and carries the socket or plate in which the pin of the strickle revolves. The strickle in this case is made in two pieces, and jointed, simply for strength and to

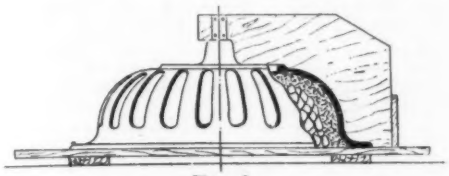
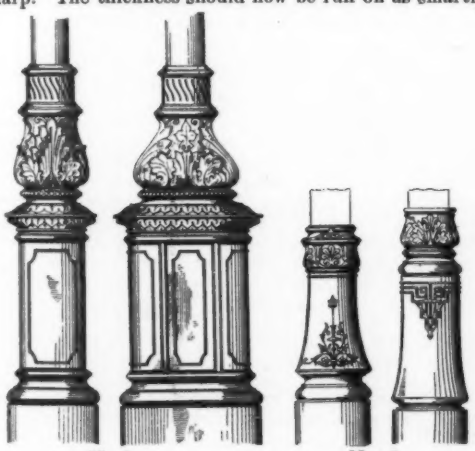


FIG. 3.

save material. There is a centre line on the plate so that it may be screwed accurately without trouble. No zinc template would be used for this, but the wood is bevelled well back, leaving the actual cutting edge about $\frac{1}{16}$ in. thick. The face and edge of template should now be varnished and oiled, as should also be the track of the template on the board. Besides assisting in a freer movement, this helps in the more ready removal of the superfluous plaster. After ascertaining that the position of the template will give the required diameter, the plaster is mixed and the block run up. It may be mentioned here that in the making of smaller sections requiring no packing, it is usual to fasten pieces of wood to the board to prevent plaster slipping as the strickle is moved round.

The thickness of the metal must now be cut from the template, the block touched up where necessary and varnished and oiled. I may mention here that very little oil is necessary; it is customary with beginners to use it to excess, with the result that it collects in angles and corners of mouldings, causing them to be blunt and rounded when they should be sharp. The thickness should now be run on as smartly



No 1. No. 2.

FIG. 4.

as possible. As before mentioned, the most satisfactory plaster work is that done quickly, and it should be noticed, while strickling, that no part is being missed, as this neglect may create the necessity for additional mixings of plaster and a prolonged use of the template over the whole job, adding to the expense and detracting from the quality of the work. All these patterns are cut into suitable pieces for handling by the moulder.

The patterns shown in Fig. 4 may be made by the spindle and swing centres or by the verticle centre shown in Fig. 5.

In large oval work the cross can be carried by a wood frame, built outside the track of the template. In such a case the template is suspended from the cross by two bolts, which take the place of the usual pins in smaller work. In large work, round or oval, the templates are sometimes fitted with wheels to give an easier movement. Fig. 5 shows such an arrangement. This fixture is in use where heavy round work is done. The sketch is self explanatory. It will be noticed the spindle extends from ground floor to first floor, through which it is drawn after the pattern is run up. The strickle in

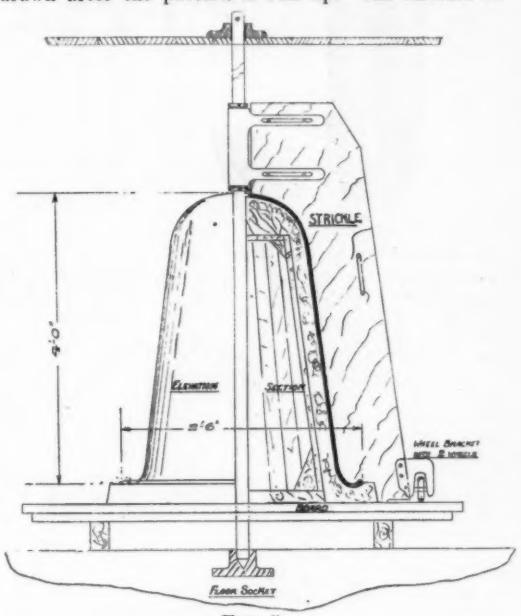


FIG. 5

many cases is of cast iron, as the extra weight assists in keeping it in position as it is pulled round.

The patterns already discussed have been finished direct from the template, but naturally there are cases in which this cannot be done. Parts have to be pared to shape, additions made, curves altered by hand or by the use of further templates, etc., and the whole assembled before ready for foundry. Fig. 6 shows such a casting, the complete pattern for same being made up of straight, circular, spindle and pared work. Half-patterns of the pipe A, B B, and C, are made on a straight board; D D is made from a centre, the complete circle being run up, from which the half and quarter are cut. The part E could be made by the same method, but it could also be made on the horizontal spindle or between the swing centres. The corner at F is pared, as are also the edges of pipes A and C at G, so that when butted together the ordinary thickness of metal is obtained. When one-half iron pattern has been made, the pieces are reassembled to make second half, which, of course, must be "handed," and it will be noticed that all parts can be used for this except F. The flange H is made of wood.

Loco. Engine Domes and Chimneys.

An interesting case of circular work where parts have to be pared by hand, is the making of locomotive domes and chimneys. Fig. 7 shows a longitudinal section and a cross-section of a dome casing.

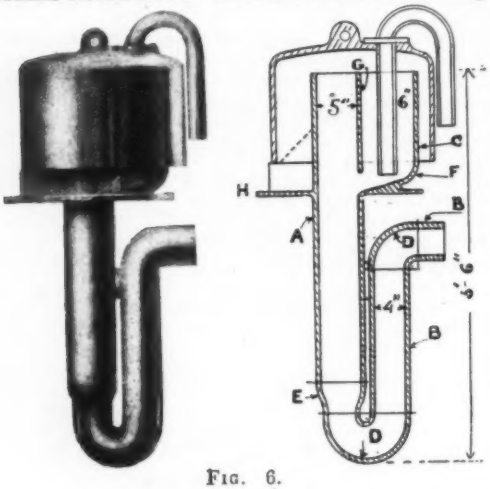


FIG. 6.

In the making of the bottom part 1, 1, a board is first prepared 6 in. or so larger than the diameter of base (Fig. 7, No. 3). A block of wood to act as the centre spindle and with the plates or socket for the pin of the strickle already in, is then fixed to the board as shown. Centre lines are now projected on to the board from the centre of the spindle, great care being taken in doing this. The spindle is then removed for the time being, and two wood strips, curved to the radius of the boiler, are screwed to the board at a distance greater than the diameter of the base, and central with the lines on the board already mentioned. A piece of wood slightly larger than the diameter of the spindle and less than the height of the strips should now be fixed at the centre of the board. This is simply to keep a hole clear for the spindle when used later.

The space between the wood strips is now filled up with plaster and scraped off with a straight-edge to the curve of the strips. This plaster block is pared to a diameter slightly larger than the base, and the spindle is replaced in the board. A strickle having been prepared to the inside shape of the dome, as shown on the left-hand side of Fig. 7 (No. 2), the plaster base is now varnished and oiled and the block forming the inside of the pattern is run up. On this four or eight vertical lines (the more there are the more accurate will be the job) are projected, the strickle being used to mark off these. The block is now pared at 2 on the plan to the curve shown on the right-hand cross-section and gradually worked in to the curve made by the strickle at 1 on the plan. The other three-quarters are treated in a similar way.

The block is now varnished and oiled and the required thickness of metal cut out of the strickle. Small pieces of wood equal in thickness to the metal required are distributed over the pared curve, and these act as guides when the outside is being pared later. The thickness or pattern is run on and the curves pared as before. The other parts of the pattern 2, 2, 3, 3, and 4, 4, being circular, are run up in the ordinary way, as already described. The iron patterns, after being filed or turned are, of course, used as shell patterns.

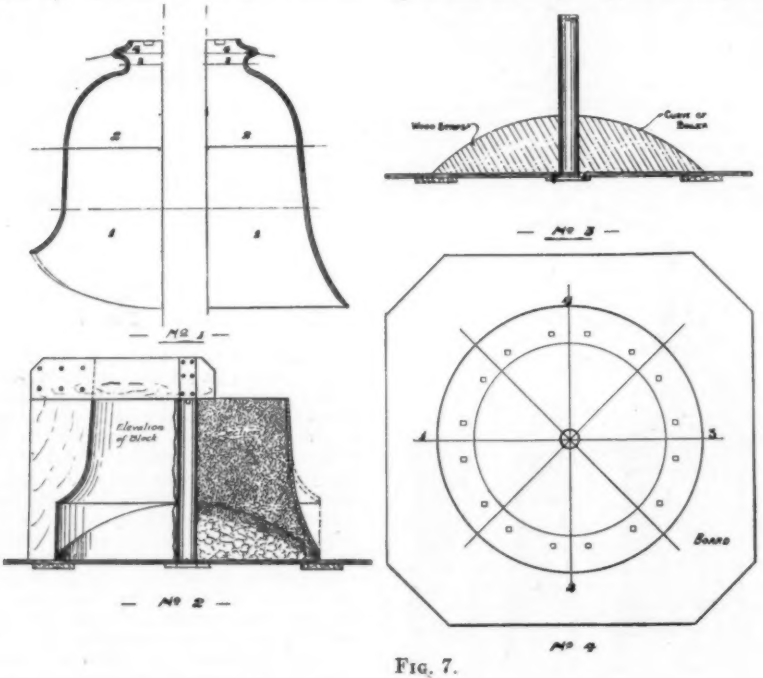


FIG. 7.

Many chimneys can be treated in much the same way, and where the shape of the base necessitates coring out, the plaster made for this purpose can be used for both core-boxes.

While, I think, no one will dispute the advantages of "stucco" where shell patterns are required, I almost fancy that where cored work is made the advantages are even greater. The plaster is, of course, made equal in thickness to that of the required casting, so that both patterns and core-boxes are made from the same plaster pattern. If

There are many ways in which plaster may be used with advantage other than in making complete patterns. On some work it may be found that a large quantity of core-prints are required, or, perhaps, snugs, small ornaments, etc. By making two, or perhaps three, according to the size of the print or ornament wanted, and

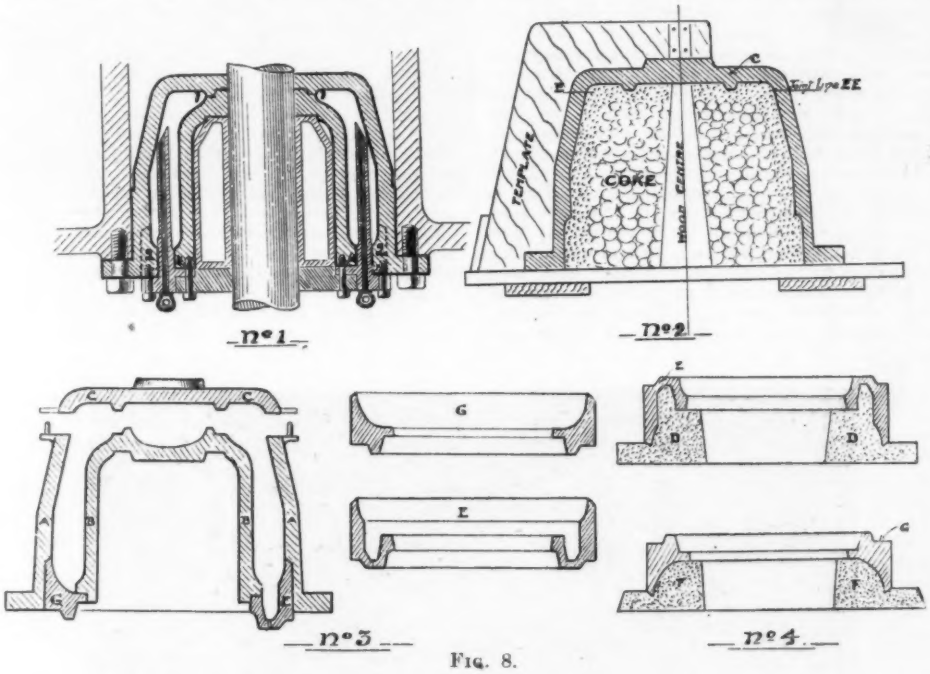


FIG. 8.

the castings required are very light, the plaster pattern is strengthened on the inside to make iron pattern and on the outside to make core-boxes. In the casting shown in outline, Fig. 8, the block forming the inside of the outer casing is first struck up, the top being finished as shown on line 1, 1, and the base as at 2, 2. The thickness is then cut from strickle and the outside A A run up in the usual way to the joint line 3, 3. This joint is cleaned, varnished and oiled, and the thickness C run on, the strickle having been again cut to do this. This joint is not, of course, necessary so far as the pattern is concerned, but it is more convenient to have this loose when making core and also allows of the core-box being more easily filed up. Instead of striking up the top C separately, the whole could have been run together and the joint line marked, or even cut through by a pin or sprig projecting from strickle, the loss caused by the cut being made up if necessary.

The block for the inside casing and its thickness B is next made, the top being formed to fit the top of the outer casing, the bottom finished at line 4, 4. The bottom part of the pattern and core-box is next dealt with. The block D, D, is made and the thickness E, E, to form the core-box is run on. The part to form bottom of the pattern and core-print is similarly treated, as shown at F, F, and G. We have now got the pieces as shown on Fig. 8, No. 3. To form pattern for the outside casing, C and A are cast as one, this with B and G forming the complete pattern. The core-box is made up from A, C, B, and E, with the necessary lugs and handles cast on.

casting a plaster mould from them, it will be found that plaster casts of the required part may be quickly,

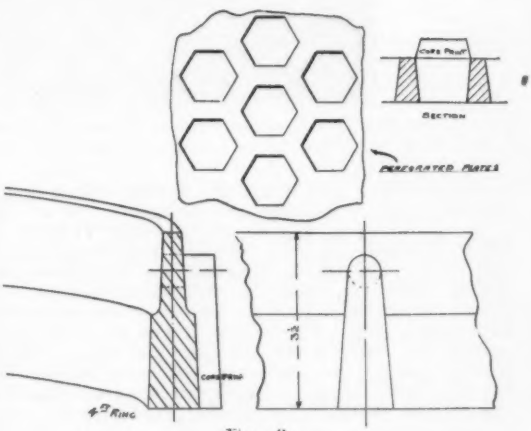


FIG. 9.

and with assured accuracy, produced by the youngest boy in the shop. These prints may be nailed on, but it will be found quite satisfactory to fasten them in position with shellac varnish, Fig. 9.

Telphers and Suspension Railways in Foundries.

The application of the telpher for reducing the labour of handling materials has come into considerable prominence in foundries during recent years. The use of this means of transport has not been confined to the charging of the cupola furnaces, but the advantages of the aerial tramway, both in the form of the telpher and the hand-driven suspension railway, have been utilised in a large measure for all other transport work. Telphers and hand-driven suspension railways, constructed according to the system of Bleichert's Aerial Transporters, Limited, introduced about 10 to 11 years ago, have proved their utility for the transport of iron, coke, limestone, etc., to the furnace, and have been used for unloading raw materials from railway trucks and from ships, the conveyance of sand into the foundry, and inter-departmental transport of materials and

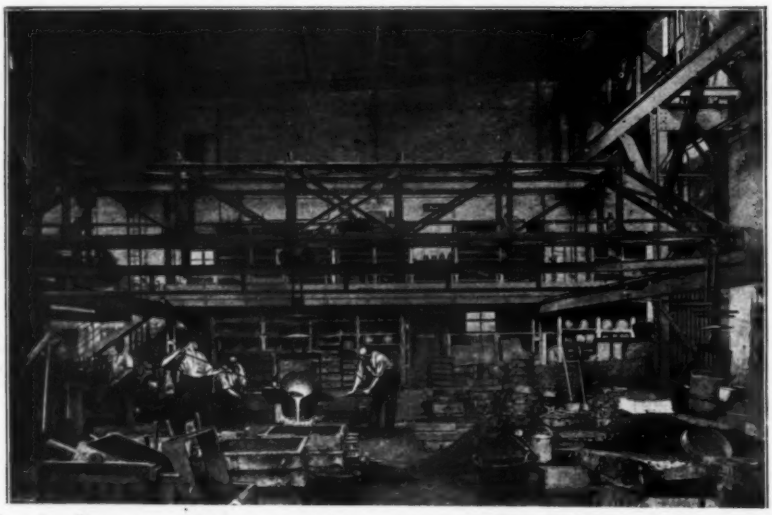


FIG. 1.—TRAVELLING BRIDGE AND HAND-DRIVEN SUSPENSION RAILWAY IN FOUNDRY.

products. Even moulds and molten iron can in this way be quickly and safely transported.

At the works of the engineering firm of J. M. Voith, Heidenheim, is an extensive telpher plant of this kind. The cupola furnaces are served by a telpher, while the foundry is provided with a hand-driven suspension railway for the conveyance of sand and molten iron. An elevator is also provided for raising the coke to the charging platform. The bunkers for pig-iron and scrap, coke and limestone, for the cupola furnace are sunk into the ground near the railway track. The telpher is carried underground alongside the bunkers and proceeds then through a tunnel under the central foundry into the cupola building. Here a single-drum vertical elevator is erected, which stands midway between the four furnaces, and the elevator cage carries two telpher cars. Each of the charging cars is provided with a weighing apparatus including a card-printing appliance, so that the loads in each car can be controlled. These weighing apparatus (see Fig. 2) are so constructed that the workman at the loading hoppers does not need to read the figures at each loading point, as every beam on which the running weight travels has an additional scale, on which notches corresponding to the class of iron are provided, into which the catch spring of the running weight engages. The workman raises the catch spring and pushes the weight at every loading point one notch further on. The scales are interchangeable, so that new classification scales, corresponding to the loads, are inserted every time. The buckets convey raw iron and coke simultaneously, the coke being placed first in the bucket. The cars pass into the lift under the control of a workman, and are conveyed to the charging platform, where they are received by another workman, who despatches them to the four cupola furnaces. On the circuit journey past the four charging hoppers the locking device on the car is disengaged by means of a detent operated by the workman and the contents discharged to the furnace. Fig. 3 shows the exit of a car from the lift and the shute over a furnace mouth. The line has a length of about 690 ft. and conveys per hour 14 tons of raw iron and 1.4 tons of coke and limestone. When the telpher is required to transport sand from the storage ground to the foundry, one car, which works reversibly, suffices.

For the conveyance of sand, small iron and molten iron in the foundry a hand-driven suspension railway is used, the loop of which is completed by a travelling bridge (see Fig. 1), so that the car loaded with molten iron can be brought right over the moulds which are to be filled. The bridge is operated electrically, the motor being controlled from the

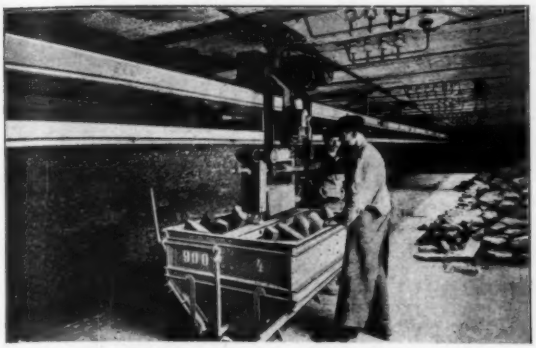


FIG. 2.—WEIGHING APPARATUS.

ground. The two ladle carriages on this railway have a carrying capacity of 1 ton, *i.e.*, 12 cwt. for molten iron and 8 cwt. for the ladle. Four cars, working with buckets, are also provided for the transport of sand and cast parts. Behind the cupolas the plant continues under the sand washery, in order that the sand may here be conveniently taken up. The accompanying illustrations show clearly various individual processes on the line. Fig. 4 shows the conveyance of sand with the hand-driven suspension railway from the sand hoppers to the foundry. Fig. 5 shows how the molten iron is taken up again in the suspension-railway ladle carriages, which are provided with threaded spindles to regulate the height of the ladle.

A plant in which the floor of the foundry and the cupola furnace are connected by an inclined elevator was built for the Société Anonyme des Forges de Vireux-Molhain by Messrs. Bleicherts. Here a loop is laid on the storage ground, I-iron carrying rails being employed (see Fig. 6). Standard telpher cars are loaded by hand when stopped, either from railway trucks or from the storage ground. At the end of the loop the cars enter a building containing the weighing appliances and then proceed to the single-drum inclined elevator, which brings them to the cupola platform, where the second telpher loop commences, which travels past the furnace mouths. The line has a total length of about 470 feet, the difference between the height of the two levels being about 140 feet, and the speed of the cars about 195 feet per minute. Twenty tons of iron and two tons of coke and limestone are transported hourly, in separate buckets. Fig. 7 gives a side view of the inclined elevator, with the cage at a height corresponding to half the hoisting height; Fig. 8 shows the entrance into the weighing house and into the inclined elevator, while Fig. 9 depicts the exit from the inclined elevator on to the charging platform.

With the exception of the men engaged on the work of loading in the foundry yard and the hands in the weighing house at the foot of the inclined elevator, only one man is required for the working of the plant. This employé is stationed on the charging platform, his duties being to supervise the entrance and departure of the cars to and from the elevator, and to manipulate the detents which tip the buckets when charging to individual furnaces.

It is true that a certain limit in the capacity results from the use of elevators in connection with telpher tracks at various elevations, on account of their intermittent working. This difficulty has been overcome, however, by the introduction of the Bleichert patent electro-ropeway. In this device the telpher carriages without their travelling motors are provided with a ropeway-coupling apparatus in addition to the driving motors, and in place of the elevator an inclined bridge, provided with a traction rope in constant motion, is inserted between the two lines. The cars travel electrically on the lower line and into the inclined bridge, where they couple automatically to the traction rope, while the current conduction rails are simultaneously interrupted, so that the car is carried up the inclined track without current, in the same way as on an ordinary wire ropeway. Arriving at the top the car uncouples automatically and proceeds electrically on the charging platform. In this way the intermittent working of the elevator is changed to continuous and the capacity very considerably increased, while the superintendence of the elevator plant is entirely dispensed with.

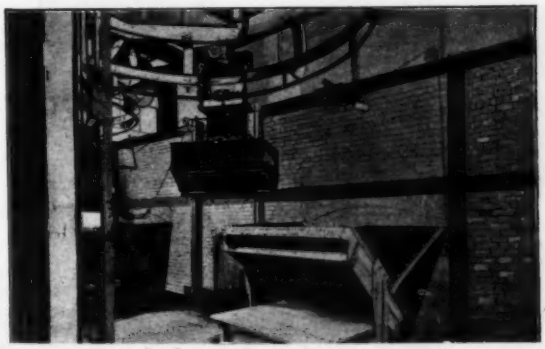


FIG. 3.—CAR LEAVING LIFT FOR THE CUPOLA.

FIG. 4.—CONVEYANCE OF SAND TO FOUNDRY.

THE WAR OFFICE have accepted the tender of J. C. Lyell & Company, Limited, 113, Great Portland Street, London, W., for a large "Auto" stationary type acetylene generating plant, patent safety back pressure valve, and blowpipes with interchangeable nozzles, for oxy-acetylene welding. These generators work on the "Carbide to Water" system, this system being specified in the War Office tenders.

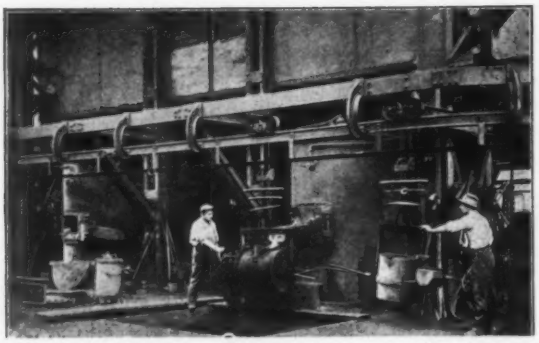


FIG. 5.—HANDLING MOLTEN IRON ON SUSPENSION RAILWAY.

FIG. 6.—CARRYING TRACK ON STORAGE GROUND.

FIG. 8.—ENTRANCE TO WEIGHING HOUSE.

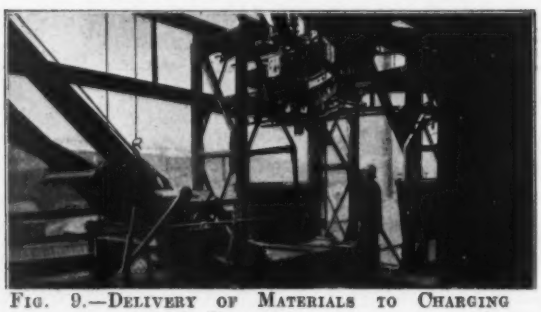


FIG. 9.—DELIVERY OF MATERIALS TO CHARGING PLATFORM.

Factor of Safety.*

BY C. E. STROMEYER.

The term "factor of safety" covers our ignorance of the real properties of materials and their behaviours when stressed. Much has been done in the past by the introduction of quality tests and the use of testing machines, but much yet remains to be done before even engineers can take the initial step of defining how many chances there are for and against occasional failures.

Let it be assumed that a piece of steel were placed before us of which the average test results show that it breaks down at 15 tons. Assume also that there is a chance that the chemical composition is not quite what it should be, that the casting temperature and subsequent heatings may have affected the grain, and that initial strains have not been entirely removed, etc. Separate these various possibilities into, say, 10 influences, of which each one will affect the elastic limit by $\pm$ 1 ton, then there are $2^{10}=1024$ possible combinations, and the chance that all the five adverse circumstances will combine to-

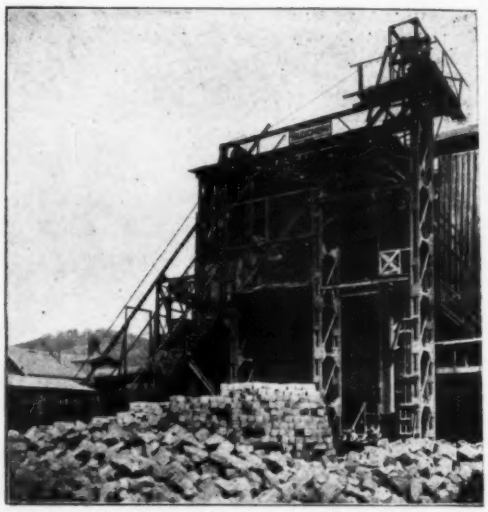


FIG. 7.—INCLINED ELEVATOR SERVING CUPOLAS.

gether and result in a low breakdown point of 15−5=10 tons per sq. in. is one in 1,024. Three is also this one chance that the breakdown point will be 15+5=20 tons. Against this there are 252 chances that its value will be equal to the average of 15 tons and 672 chances, or 67 per cent., that the breakdown point will be between 14 and 16 tons per sq. in., etc. Suppose now that nine tests have been made of this material, then the results will very likely be as follows :—One of 13 tons, two of 14 tons, three of 15 tons, two of 16 tons, and one of 17 tons. Most engineers would accept the average result of 15 tons and apply a factor of safety without looking into the distribution of the test results, but the more correct procedure would be to say : These nine tests indicate that if we were to make 1,024 tests, one of these would give a limit of only 10 tons per sq. in., and in order to be safe we must not depend on a higher value. If with another lot of steel,

* From a Paper read, March 28, before the Staffordshire Iron and Steel Institute.

the test results should be as follows :—One of 14, two of 14½, three of 15, two of 15½, and one of 16, then the conclusion to be drawn would be that there is a chance of one failure occurring at 12½ tons. On the other hand, if the test results were to be more scattered, say one test of 11 tons, two of 13, three of 15, two of 17, and one of 19, the conclusion should be drawn that one failure per thousand tests is likely to occur at 5 tons per sq. in., and this should be the permissible maximum stress. It will thus be seen that the habit of engineers to accept average results might with advantage be replaced by the one adopted by astronomers, chemists and others who, when stating average results, also add a ± quantity which indicates the probable average error. To be of value in this respect laboratory test results should indicate not the probable mean error, but the maximum one, which is, of course, outside the limits of the extremest tests. Then, however, much of our uncertainty would be removed, and the factor of safety might be correspondingly reduced.

Confining our attention to steel, the first problem should be the determination of a correlation between the chemical constituents and the physical properties of this metal. In each new edition of my work on "Marine Boilers" I endeavour to fill up certain blanks in a skeleton table in which chemical impurities are compared with the following properties of steel :—Tenacity, elongation, resistance to impact, pliability when hot, cold and after being hardened or tempered, weldability and corrodibility, to which list the following might with advantage be added—fatigue resisting powers, ageing properties and reliability or treacherousness.

As regards tenacity the following formula will give the tenacity of mild steel to within about ± 2 tons per sq. in.—

$$19.75+25\ (C.C^2)+11.5\ Si+30\ P.+205\ N.$$
$$+36.5\ As+9.5\ S.$$

Here the several letters stand for the percentage of the respective chemical elements.

It will be seen that nitrogen has a much greater effect than carbon in increasing the ultimate tenacity, and unfortunately too it is even much more powerful in making mild steel brittle and treacherous. This treacherousness is as yet difficult to define, but judging from a large number of failures in practice, so-called unaccountable failures may be expected to occur when the percentage of phosphorus, which also causes brittleness, plus five times the percentage of nitrogen, exceeds 0.080 per cent.

This limit is very much exceeded in all Bessemer steels, nitrogen being more readily absorbed under the high-pressure conditions of the Bessemer furnace than under the low ones of the open-hearth. Unfortunately a high temperature, unless it be associated with a vacuum, will not drive nitrogen out of steel when it has once got into it, with the result that much of the steel which is turned out of basic open-hearth furnaces is comparatively rich in nitrogen, for in these furnaces the ratio of scrap to pig is very large, and steel scrap, especially on the Continent, consists largely of basic-Bessemer crop ends and even whole ingots, or of molten metal.

The British basic open-hearth furnaces use comparatively little steel scrap, and their products are comparatively free from nitrogen.

The probability that the nitrogen, which is forced into the steel in the Bessemer converter and which is not removed by subsequent re-melting in the open-hearth furnace, is responsible for so-called inexplicable failures, is confirmed by the fact that this class of failures is most frequent in those countries (Germany and America) where the acid open-hearth furnace is conspicuous by its absence. Then also during the first two decades of mild steel, before the basic open-hearth furnace had been invented, failures of steel shells of boilers never occurred, whereas since basic steel is being used for shells, occasional explosions occur.

Treacherous qualities of steel must possess ageing or maturing properties, their natural condition being one of brittleness which has been temporarily altered by heating and rolling; at any rate, steels rich in nitrogen or phosphorus may behave well in the testing machine, and fail in the shop, or they may even survive the workshop treatment and fail subsequently. My researches into this subject were as follows: Samples were injured by shearing; of these, some were bent at once and others after waiting (ageing) for a few days, weeks or months. Generally the old samples were rather more brittle than the newly-sheared ones. Samples were also planed on their edges, nicked and bent either at once or after waiting. They too showed ageing effects, but neither test discriminated between those steels which had failed in practice and the more reliable qualities. The ageing effect could be produced rapidly by simply immersing the samples in boiling water.

Curiously enough, amongst all the steels tested by me by bending at a blue heat, those which were rich in phosphorus or nitrogen failed more readily than others. This test is not a very convenient one, and could not be relied upon to discriminate between good and treacherous steels, but the experience suggests that some so-called mysterious failures may be due to steels rich in nitrogen being warmed with heaters before bending, an operation which may have made these plates brittle, whereas acid plates would not have suffered.

At one time injudicious annealing may have been the cause of unexpected failures, but as this treatment can be detected by subsequent microscopic examination, it cannot now be called mysterious. On the other hand, annealing, because it encourages the segregation of the impurities in steel, may be looked upon as being an accelerated ageing procedure, and it is more than probable that one quality of steel may get spoilt under certain annealing conditions which do no harm to other qualities. The risk of ageing, in the widest sense of the term, is particularly great with alloys, and many engineers object to their use except for special purposes like bronze bearings, for it is well known that certain nickel-steel alloys, brasses and bronzes may become absolutely rotten after a time, though there is no certainty that this will be the case; also it is well known that the alloys in fusible plugs change their nature and must be renewed every 12 months.

THE text has been issued of the Wages Bill, a measure introduced in the House of Commons by Sir R. Cooper, the Member for Walsall, and supported by Colonel Pryce-Jones, Mr. C. A. M. Barlow, and Sir M. Wilson. It is described as "a bill to provide for the approval of a living wage by local authorities, and for the registration of employers who pay less than approved wages." According to the accompanying memorandum, the object of the bill, which applies only to England and Wales, is to discourage the payment of low wages by requiring all employers employing any person over the age of 21 years at less than the "approved rate" as defined by the bill to register such employment in a register to be kept by the local authority. The approved rate of wages for a district is to be determined by order made by the local authority, but the bill provides certain hourly rates varying for men and women, respectively, and for districts with a population of more or less than 20,000, which are to have effect until the rates have been so determined, and which are to constitute the minimum rates which may be determined by a local authority.

Pattern-Making Miscellany.

By D. Gordon, A.M.Inst.Mar.E.

The common constructional methods practised in general engineering pattern-making in wood have to be very considerably modified, or alternatively, amplified, when applied to the production of electrical or scientific-instrument castings. The chief reason for creating these differences is that the initial pattern produced is usually only the means whereby a metal pattern can be obtained, which obviously means very economical initial production, as the manufacturer has to consider a double cost for the required master pattern. Also, as the work is very frequently of a very light character—often of the "flimsy" order—other materials, apart from wood, are very often requisitioned, these ranging from cardboard to plaster-of-Paris and soft metal. The use of these materials may give rise to the question of

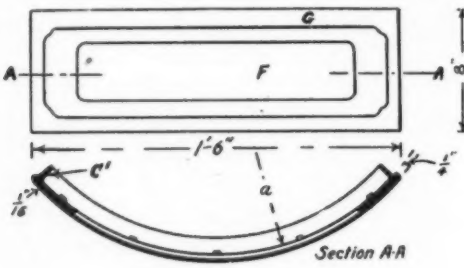


FIG. 1.

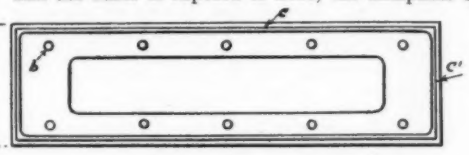


FIG. 2.

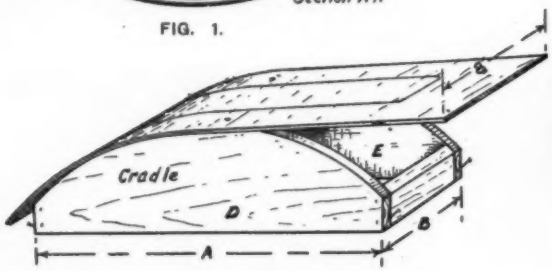


FIG. 3.

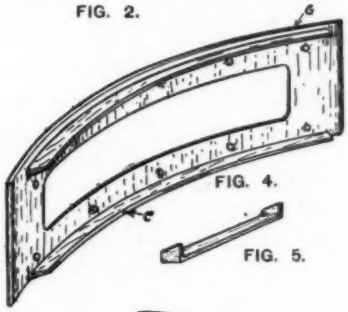


FIG. 4.

FIG. 5.

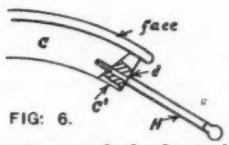


FIG. 6.

durability and strength obtained, but these are secondary considerations so far as the economical production of the master pattern is concerned, and no great need is exercised in these directions, it being, as a matter of fact, very commonly required to form intricate patterns of not more than $\frac{1}{16}$ in. sectional thickness without the aid of core prints to give pattern support. It thus follows that some patterns are of necessity "blown together," and it is with a sigh of relief that the pattern-maker deposits his work into the hands of the moulder, who, of course, receives it with his customary grumble combined with argumentative questions regarding taper, etc.

Recording Instrument Face.

As one example of the many divergent processes adopted for this class of work, as distinct from the more orthodox practices, Fig. 1 gives the elevation and sectional plan view of an "edgewise" recording instrument face. From the dimensions given it will be obvious that to construct the circular form of the pattern in segments is out of the question, and also core-print support is equally so, owing to the expense entailed by requiring a core-box, etc.

To produce this at its lowest cost the curved portion of the face is made of wood and bent to the required curvature. The most suitable wood for this class of work (*i.e.*, bent work) is cedar, which is readily affected by both heat and dampness. The required length of the material is obtained from the development (Fig. 2), and is made up the short way of the grain, being in thickness the face thickness minus the facing strip G around the edge ($\frac{1}{16}$ in. thickness).

To bend the material it is damped upon one face and the other is exposed to heat, the dampness opening up the grain of one face, and the heat closing up the other, which naturally gives the material a curve. To obtain the desired curve (*a*, Fig. 1), a cradle (Fig. 3) is formed, being boxed together and at its length A and width B small enough to go within the surrounding flange C, C' (Figs. 1 and 2). The cradle sides D and E are cut to the required curve and care must be taken that no "winding" occurs along the curve edges. The cradle is firmly fixed and the prepared wood is bent around and along the edges, being secured to the cradle as each stage of the curve is obtained. The dial hole F (Fig. 1), is not cut out previous to the cradling, but only marked upon both surfaces of the stuff. The surrounding flange C is now made up by means of segments half-lapped together where they abut each other, and secured into position by means of fine screws, and at their bases having leather filleting to give additional support and incidentally assist in retaining the bent face into position.

The facing strip G (Fig. 1), is now fixed on, being

previously cut to the developed shape, in either cardboard or presspahn (an insulating material familiar to all electrical workers), which latter can be obtained in thicknesses from $\frac{1}{64}$ in. upward. The facing is well glued and screwed, curved blocks being clamped upon it until the glue has set. Cardboard of presspahn will be found more economical and satisfactory to use for this work than wood, as this latter when placed lengthwise of the grain—short grain being obviously out of the question—has a tendency to kink during bending, or most probably, if the curve is sharp, to break.

The dial hole **F** is now cut out and the pattern at this stage well varnished, but not within the proximity of the cradle, as this latter is removed after the varnish has hardened. The bosses *b* are then fixed at their respective positions, and the pattern well varnished, being afterwards cast up in any suitable metal and converted into the pattern proper.

The end strips C^1—C^2 of the flange are required loose for moulding purposes, and a pattern end piece, Fig. 5, is made, this latter having formed with it the desired fillets contiguous to these ends. This is also cast in metal and attached to the main body by means of screw-skewers, as shown in Fig. 6, where it will be noted that the thread enters only a slight distance into the sides when connected with the main body of the pattern, the shanked portion of the skewer abutting upon the loose piece. This form of skewer ensures the loose pieces being kept securely and accurately in position, and is in every way superior to the usual push-in wire skewer.

Coil Connection.

Another example showing the divergencies of this particular class of pattern-making is the coil connection, Fig. 7, which if made up as a worm pattern

FIG. 7.

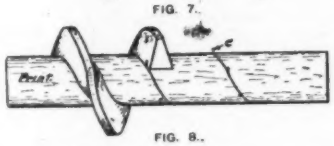


FIG. 8.

with its base cut through by a print would entail considerable cost. To limit this cost a print, Fig. 8, is turned to the interior or root diameter of the coil and upon its surfaces the one helix of the coil root is marked. At various positions, following out this helical curve, nails *c* are driven into the wood print, projecting above the surface of this latter approximately $\frac{1}{4}$ in. A piece of lead, previously made up to the section and full development of the coil, is bent around and fixed upon the print, the nails being the guides for obtaining position. The lugs B B are next attached and a serviceable pattern capable of producing many castings is thus obtained.

Motor End Cover.

Plaster-of-Paris is also another material very frequently substituted for wood, being used chiefly when the work is of a light and uniform character and generally as the means for reproducing a metal pattern. An example frequently made in wood by those unacquainted with the procedure for plaster work is shown in Fig. 9, this being a motor end cover perforated at three positions with lightening holes *a*, *a*, *a*. To make this pattern in plaster a pattern block or dummy (D, Fig. 10), is struck up by means of the board C which rotates around a wood spindle, which latter is spigoted firmly into the base board G. The dummy is made up by surrounding the spindle with broken coke, which in turn is covered with plaster poured over it, this being mixed to the consistency of a thick cream. The board C is cut to the form and size of the pattern's interior, which is in every respect the same as a struck-up core, the plaster obviously being struck up to the shape of the board edge.

When the plaster has set it is given a coat of shellac varnish which, after drying, is coated over with a light oil, this latter acting as a parting. To form the lightening holes *a*, *a*, *a*, and to obviate the necessity of cutting these out from the plaster at a later period, plastacine (*a*, Fig. 10) made to the metal thickness and shape of the holes is placed upon it at

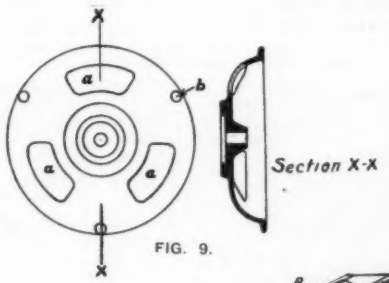


FIG. 9.

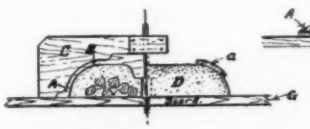


FIG. 10

FIG. 11

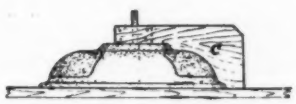


FIG. 12.

the requisite positions and secured to the pattern block D. These plastacine cores are made by bedding-in the material between two wood strips A, A, Fig. 11, the thickness of these strips being the core or metal thickness required, the plastacine being struck level with these strip thicknesses. A templet (B, Fig. 11) cut to the required *developed* lightening holes is now used as the guide for cutting the plastacine to shape, these being then removed and, as already mentioned, fixed to position. The lines A and B marked upon the board C (Fig. 10) give the circle wherein these rest.

The board C is now recut to the pattern's *exterior*, further plaster is added and formed to shape by revolving the board, no plaster obviously being required at those positions occupied by the plastic material, these being of the same surface level as the struck-up plaster. When this has set the positions of the bosses are allocated, further plaster being added to make up their thickness.

To form cohesion between the main struck-up body pattern and the added plaster to form these bosses, the surface is slightly roughened up. The board C is re-cut at the required position to give the bosses level, their formation being afterwards obtained by paring; also the lightening holes are rounded at their edges and the pattern prints *attached* if the bore is to be of differing diameters, or alternatively these may be formed during the striking up with the main body of the pattern when of standard size.

These patterns are invariably moulded upon the dummy, this latter acting as a base for the pattern proper during the ramming up of the box, thus obtaining stability so necessary for the initial processes when this material is used for pattern work.

Mems. for Young Moulders.

By SIDNEY G. SMITH.

Always be at your work at the proper time. If you habitually lose time your foreman's attention will soon be drawn towards you. Good timekeeping, with attention to work, will go a long way to make your services remunerative and increase your opportunity for promotion.

Do not continually enquire about the time, it is a bad sign. Interest and activity in your work will kill the boredom of the clock. You will enjoy the rest all the more, and it will pay you and your master.

Always endeavour to have your work well in hand. It is better that you should wait for the metal, than that the metal should wait for you.

At all times use the foundry tools with care, as though they were your own. They are costly, and their cost has to come out of the profits of the castings you make.

When venting a mould or core, always make provision for the air to get away. If you do not, it will return to the mould and then something will happen. Do not try to vent a pattern or core box with the wire. It is not necessary, and disfigures either.

Ram the moulds regularly, according to depth and thickness; otherwise scabs and swells will be the result. Do not spare the rammer and spoil the mould; neither abuse the rammer with the same result.

Always warm the skimmer and feeding rods before using them. If you forget to do this it may cost you or some one else an eye, or cause some disfigurement.

If you see a comrade in difficulties do not jeer at him or pity him; give him what assistance you can. You will be very fortunate if you do not often want such help yourself.

If you make a bad casting, endeavour to profit from its badness. It is the only good result that can come from a bad one. If you do not, you may make another waster and perhaps something unpleasant may follow.

Do not carry an air of superiority. Remember the adage, "Pride goeth before a fall." There are many falls in a foundry.

Do not make a job last as long, but as short as possible. If your foreman is not watching you, someone else may be, and you may not get that job again when it comes in.

If you can suggest to your foreman an improvement in means or methods, it is desirable to do so in a becoming manner. The foreman is only human, and cannot be expected to know everything. If he is a reasonable man he will appreciate the suggestion; but if he is unreasonable, in future, hold your peace.

When in doubt, seek advice from those who can best give it. Advice is often too cheap and plentiful, but you must learn to discriminate.

Make yourself as much as possible master of your trade. It will prepare you for eventualities which may arise. Preparation is the battle half won.

You cannot better utilise your spare time than by the study of chemistry and metallurgy. The knowledge of these subjects will be invaluable to you, as success in the mixturing of sand and metals depends largely upon analysis and manipulation.

Remember your trade is an art and a science. Apart from being a mechanic, you are the possible artist and scientist.

To attempt to make theory prove practice is to commence at the wrong end. Practice must prove theory.

The practical part of your work is of chief importance. Technical education, theory and science should be combined in the whole of your daily work.

Cultivate keen observation and a spirit of enquiry.

If in the foundry you see a moulder do something you do not understand, quietly ask him why he does it, and if he is a sensible man, he will give you an intelligent answer, and you will be the wiser for it.

Do not be crestfallen because of disappointments in your work. Uncertainties and such-like are the charms of foundry life. But let no point of failure pass unnoted, and always remember in future.

In any part of a moulding operation get a clear idea of what you are going to do and why you do it. Some copy the action of others, and do not know why.

Foresight is essential; cultivate it. It is of little avail to close the stable door when the horse has escaped.

Pay due respect to your foreman and work in his interest and to his instruction. Do not forget he is officially responsible for all that goes amiss in the foundry, and his burden is often as much as he can well carry.

If at any time you know of a defect in your work, do not try to hide it; show it to your foreman at once, for if you do not it will be found sooner or later, and you will be distrusted.

Civility is a virtue which is not expensive; be generous with it. Incivility brings its own evil reward.

Cultivate self-control and discipline. It is the best preparation for controlling others and the making of a disciplinarian.

WASTE-HEAT BOILERS AT OPEN-HEARTH FURNACES.—Interesting data relative to economies effected by the installation of waste-heat boilers in connection with the open-hearth furnaces at the South works of the Illinois Steel Company have been published. Previous to putting in the boilers all the steam used by the gas producers was obtained from the blooming-mill boiler-house through a long small main. Two Stirling boilers of 4,000 sq. ft. of heating surface and large motor-driven fans were then installed, and the present feed-water system carries out the idea of waste-heat utilisation to the utmost extent. The warm waste cooling water from the bulkhead and port pipes of the furnaces is supplied to the Dyblie gas-valve hood instead of cold water. After being heated still further by the gas valve, it flows from a semi-circular trough to a small tank, the water-level of which regulates the amount supplied to the Dyblie valve hood by a float valve, according to the requirements of the boilers. From the small tanks the water flows through a pipe under the floor to the feed pump, but, before entering, the exhaust steam from the feed pump is discharged into the water. These three additions of heat are sufficient to raise the feed-water from 35 deg. to 200 deg., equivalent to 90 boiler h.p. The boilers are now making about 825 boiler h.p., which is equal to 1,900 tons of coal a month obtained from the waste heat.

Foundrymen's Visit to the Daimler Works.

On Saturday, May 2, about fifty members of the Birmingham Branch of the British Foundrymen's Association visited the works, at Coventry, of the Daimler Motor Company. This was the second visit, the first having been paid in the spring of 1910. The party were specially interested to observe developments made in the plant during the interval, especially as on the occasion of the first visit some of the extensive shops had only just been erected. The visitors were piloted round the works by Mr. A. Harley, the general manager of the foundry, assisted by Messrs. A. Wardle, A. Fraser and several of the charge hands, with Mr. Topliss, of the laboratory staff. The bulk of the time was spent in the foundry, but the erecting shops for general cars and omnibuses and commercial cars were also visited, these shops being about 600 ft. long by 160 ft. wide. Of the 4,500 employés some 400 are engaged in the foundry. An important feature installed since the last visit is a "Stock" oil-fired converter, for steel castings (this converter was described in our issue of October, 1911. The vessel produces casts varying from 10 cwts. to 16 cwts. of steel, of which the following results are typical:—Tensile strength, 32.55 tons per sq. in.; elastic limit, 23.18 tons; elongation, 8.59 per cent.; Brinell hardness test, 143.

In the erecting shop 100 chassis per week are regularly turned out, and these find employment for large numbers of tinsmiths, coppersmiths, and fitters. The most promising development is the large demand for commercial lorries and motor omnibuses. Among the latter were two fine-looking vehicles just finished for Turkey. The foundry has been twice extended in the course of seven years. The visitors were very much impressed by the clean and orderly appearance of the department, and it was agreed that the iron frame constructed of channel iron at a height of about 18 in. for the purposes of supporting the casting box, instead of placing them on the floor was a very good labour-saving improvement. The moulders in the cast-iron section are largely employed in the production of cylinders, sleeves, cylinder heads and motor-cycle cylinders, and on account of the important nature of the work all material coming into the foundry is analysed. There are three Hyslop drying stoves, and the cupolas turn out 14 tons of iron per day. Of cast iron the output of castings is about 25 tons per week; of malleable 6 tons; of steel 6 tons, and of gunmetal 5 tons. There are three annealing furnaces of the Gibbons type, each of which will hold 6 to 7 tons of light castings. The laboratory is a well-equipped department, in which all results are carefully tabulated. Among the latest appliances is an oxy-acetylene cutting plant, which is found very useful in fettling steel castings.

On the conclusion of the visit, the party were conveyed by motor to the King's Head Hotel, where they were entertained by the Daimler Company. Before leaving, Mr. C. Heggie proposed a hearty vote of thanks to the Company for allowing the visit, and to Mr. Harley and his colleagues for kindly conducting the party. Mr. Heggie said they were under a great obligation, not only for being allowed a second time to see the works, but for the full explanations and the entire absence of restriction in their tour.

Mr. Dalrymple seconded, and said the visit had been most enjoyable and profitable. He thought the apparatus for repetition work could hardly be beaten in the kingdom.

The vote was carried with acclamation.

Mr. A. Harley, in responding, said it was a great pleasure to the members of the staff to know that the visit had been enjoyed. It was quite true that they had a great many difficult jobs to do, but he was assisted by a most loyal staff, and they got every encouragement from the management, who spared no expense in the provision of suitable and sufficient plant, so that they were able to turn out what they believed were first-class castings for the motor trade. He had the privilege of starting the foundry, but no department of such dimensions could be carried on without skill on the part of his

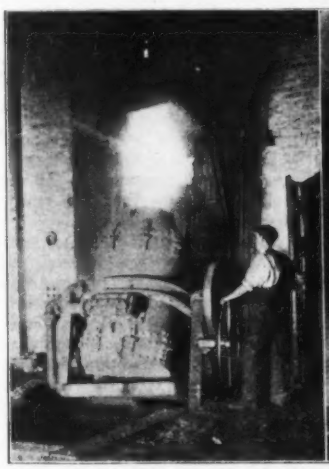


Fig. 1.—"Stock" Converter at Daimler Works, during Blowing.

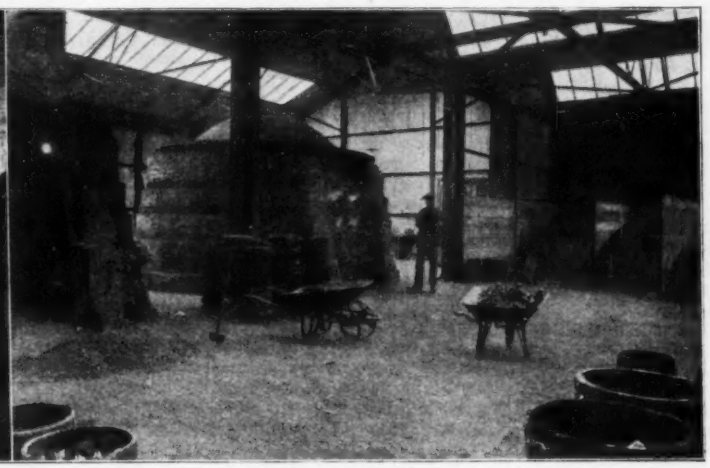


Fig. 2.—Annealing Ovens for Malleable Cast Iron, at Daimler Works.

colleagues and painstaking industry and loyalty from every members of the staff. He had never come across a body of workers showing a better feeling.

Mr. C. Grindlay announced a series of future arrangements. On July 6 it was proposed to visit the works of the Electric Construction Company, at Wolverhampton, and at a later date they hoped to visit the University.

District Iron and Steel Works, Smethwick.

Visit of Birmingham Foundrymen.

Members of the Birmingham Branch of the British Foundrymen's Association, on May 25, visited the works of the District Iron and Steel Company, at Smethwick. A visit was paid to these works four or five years ago, but since then there have been very important changes in the plant and developments in the methods of manufacture. The whole of the plant, with the exception of one mill, which also is about to be converted, is electrically driven, and a system of continuous rolling has been introduced into some of the departments. By the kindness of Mr. Leonard Broughton, the managing director, the time of the visit, originally fixed for the afternoon, was altered to 7 o'clock in the evening, and as the works do not close until 9 o'clock, the visitors were able to witness all the principal processes in operation. The visitors were received by Mr. Abraham Phillips (general manager), Mr. R. Latham (mill manager), and Mr. T. Nicklin.

The staple business of the firm is the rolling of a variety of steel sections and also steel tubing, close-joint or welded. Birmingham being the home of the bedstead trade, the output comprises tubing for pillars, frame angles, stretcher bars and bent or straight foot and head rails. The Company also produces a number of specialities such as electrical conduits and gas-pipe strip, the total number of steel sections produced by the five separate rolling mills being over 200. Another specialty is the making of grooved steel motor-car wheel rims. These are rolled from the billet, and the mill producing these is stated to be the only one of its kind in the country. Tubes are also rolled direct from the billet.

The works with their buildings and "banks" cover eight acres. The steel billets, of suitable section and 12 ft. long, are brought by canal to the wharf, which extends along the whole line of the Company's mills. They are handled by electric cranes and pass on skids to the elevator, which raises them to the upper end of a special inclined furnace. The billets are inserted broadside-on into the furnaces and the same motive power carries them slowly down to the lower exit, which they reach at the required temperature. From this continuous furnace, which is gas-fired, the billet, when white-hot, enters the continuous rolling mill, and passing in an unbroken journey through the successive reducing rolls of the mill, shoots out from the last of these to a length of 140 to 150 ft. This mill is used to turn out 1¾-in. by 1¾-in. angle sections by 12-in. gauge, or any section of gas strip up to 6½ in. wide. Apart from the increased rapidity and the great saving of labour effected by the continuous method, there is the advantage, it was pointed out, that in cutting up the sections into standard lengths there are only two ragged ends to be cut to waste in the whole 140 ft.

The adjoining rolling mill is of the ordinary kind, the billets being guided backwards and forwards through alternating rolls to obtain rounds of from ½ in. to 1½ in. diameter for the making of bolts and nuts for constructional work, or any other section of similar proportion. In the third mill, 1½ in. to 3½ in. diameter rounds are rolled, also corresponding squares, flats and sections. The output of this mill also includes gas-tube strip up to 8¼ in. wide, and sections for railway spokes, the latter being another specialty of the firm. A fourth mill is used for producing smaller strip and for rolling tubes straight. The fifth rolling mill is of the same type, though on a rather larger scale.

The plant includes apparatus for bending into shape bedstead head and foot rails, and a battery of presses for the cold-stamping of saddles and clips for conduit pipes and similar small work. The motor-car rim sections are cut into lengths and packed in the straight. A separate extensive department is devoted to the finishing of the electric-conduit tubes.

At the conclusion of the visit, Mr. Dalrymple proposed a vote of thanks to the directors of the Company, and to the gentlemen who had conducted the visitors round the works.

Mr. R. Buchanan, in seconding the vote of thanks, said that they had observed a considerable change in the works since their last visit. A great improvement had been effected by the introduction of electrical driving, and they had also greatly admired the work done in the continuous rolling mills.

The vote of thanks was carried by acclamation.

Mr. Phillips, replying on behalf of the firm and his colleagues, said it had been a great pleasure to them to take the members round the works. It was highly desirable in works like these that the equipment should be of the most advanced type. They were compelled to go on advancing if they were to be successful in meeting competition. They had coming into the works nearly 2,000 tons of steel raw material weekly, and they turned this out into finished sections of many sizes and descriptions. During the last three or four years changes had gradually been introduced, and they had now only one engine driven by steam. That was the one which drove the continuous mills, but in a short time that would be replaced by an electrical motor.

MAKING THE FOUNDRY PAY.—According to Mr. Stuart Dean, in a Paper read recently before the Pittsburgh Foundrymen's Association, a method of bringing strong pressure to bear on the departmental heads is to make up the following tabulated record:—(1) Number of pounds of good castings turned out each month by a department. (2) Total foundry hours of the department per month. (3) Moulders' hours only, per month. (4) Helpers' hours per month. (5) Coremakers' hours per month. (6) Casting cleaning hours per month. (7) Hours of any class of help, such as cupola, crane men or foremen. Divide the first item, or the number of pounds of good castings turned out by the department, by each of the following items:—2, 3, 4, 5, 6, and 7 and multiply by the hours in the work day, which gives the following records:—(8) The day's output for each moulder. (9) The number of pounds of castings each foundry helper helps on each day. (10) The number of pounds of castings a day each coremaker makes cores for. (11) The number of pounds of castings each casting cleaner cleans each day. (12) The number of pounds of castings turned out *per capita* of all other help (cupola, crane, foremen).

Unskilled Labour in the Foundry.

A Paper on the "Profitable Utilisation of Unskilled Labour in the Foundry" was read by Mr. Arthur J. Key at a meeting of the Lancashire Branch of the British Foundrymen's Association recently. Mr. Joseph Simkiss, Branch-President, was in the chair.

Mr. Key, after deploring the under-estimate of the value of the products of the foundry as compared with the value placed upon similar articles produced in fitting shops, traced the cause of this largely to competition, and to the careless book-keeping of people starting small foundries, and being content with what they regarded as small marginal profits, but which soon brought them to grief, and at the same time lowered the price of castings. The result of this was that it had now become necessary for foundrymen to look for ways and means of producing more cheaply than before, and consequently it became advisable for them to see how much they could get performed by unskilled labour. He did not wish to suggest that skilled labour could be dispensed with in the main, but it often happened that skilled men, for various reasons, did not make the most of their abilities, and did not maintain the standard of all-round first-class hands that formerly existed. As far as possible the skilled men should be kept to the more highly-skilled classes of work. The moulder should be kept, as far as possible, from doing anything that a labourer could do. Labour, of course, varied greatly in different localities. He had seen some really first-class men made out of farm labourers. Employing a maximum number of unskilled labourers was not an unmixed blessing, for it threw much extra work and worry on the shoulders of the foundry management. It was no easy task to train a labourer or youth to make moulds or loam cores, and it might be asked why they should be so trained. The need had been brought about to a large extent by the moulders themselves being unwilling to work a moulding machine. This had necessitated bringing in unskilled labour.

After giving reasons for his belief that unskilled labour was cheaper as far as the finished product was concerned—two being that the skilled man takes many unnecessary precautions to avoid bad work, and that the unskilled has nothing to unlearn and therefore does only what is necessary—Mr. Key went on to show how, instead of this greater utilisation of the labourer being inimical to the interests of apprentices and craftsmen, it would be to the benefit of both, for they would be relieved of all the purely labouring and less-skilled jobs, thus enabling them to devote and concentrate all their attention to the more highly skilled. Mechanical appliances should be used as far as practicable. Where electricity or compressed air was available there were many portable appliances that could be profitably used. One man with a portable electric riddle could do the work of any four men riddling by hand. Where there was large work in progress this would mean a great saving in physical exertion, which could be thus reserved for the latter part of the day when pouring time arrived. Then there was the pneumatic rammer, with which a labourer on a long job could do most of the back ramming. One or more labourers should be kept, according to the amount of the work, to make all core irons, lifters, gaggers, and all tackle. Here there was great scope for training labourers to become more profitable assets. When a man became used to making an open-sand bed he would fill it in an incredibly short time. He (the speaker) knew of instances where the bed man would take a set of core boxes and, after having been broadly informed of the style of grid required, would make them so that when the coremaker got them hardly a prod would require snipping off. Not only should the bed man be put to core irons, but he should also make any tackle that was suitable to be made in open sand. It was surprising how much more efficient the bed man became than the moulder. Give the bed man a set of boxes or mark out some plates or binders, he simply viewed it as part of a day's work; while the more skilled man would spend a lot more time to make his work appear neat. No moulder should be required to fit up boxes: a trained labourer could prepare them and rig them up ready for him.

Bolts, cramps, wedges, and all fastening tackle should be kept in order by a man kept for that purpose, so that while the moulder was doing his work of making up runners, vents and so on, the labourer could be putting on all the necessary tackle for fastening down, to be finally tested by the moulder in charge. Again, a labourer should be responsible for keeping all blacking and claywash articles well stocked, so that there would be no delay whenever they were required. The moulding and core-making machines could be profitably used by the aid of labourers in the jobbing foundry. There were machines which would cope with a large range of work, even for odd jobs. Sometimes it was only possible to ram half of the pattern on the machine because of an irregular joint, but even this would pay, for the man who worked the machine could ram that half-mould in considerably less time than by hand, though, of course, the half-mould would be passed on to the moulder to complete.

Again, Mr. Key continued, a considerable number of cores made in the jobbing foundry could be profitably made on the moulding machine by trained labourers. Cores which a core-maker would consider he had done well if made in an hour, could be made ready for the stove by a machine hand in fifteen minutes. A great saving could be effected, too, by training a labourer to pour all castings requiring a crane ladle. His own experience in this was that a labourer became quite proficient in a very short time, and did the work more quickly than the moulder in most cases. Then it left the moulder more liberty to attend to his runner plugs, if any, and see to his vents, without the need for seeking help from the men on another job. Men should be trained and kept to certain things, if possible, so that they could go ahead without a lot of explanation, especially in the case of moulding cores, tackle making and general preparations for casting time.

In the repetition foundry there was hardly any job for which a labourer could not be trained, but care should be taken, of course, not to put a labourer to the class of work which a skilled moulder could produce cheaper. In the pipe foundry he did not think that the machines at present available could produce as cheaply as by hand, for practically all straightforward pipes were rapidly made by labourers, and unskilled labour could be used to a great extent in the other work that was done, as in jobbing foundries. In shops devoted principally to automobile castings, the moulding machine could be used to great advantage for both moulds and cores, and many mechanical appliances to save expensive labour could be introduced. For instance, a core-

maker starting to make a large jacket core had some delicate work to do. If he had to bend his own irons it might take him nearly as long as to make a core, but these irons could be made by a youth by mechanical means, and so shaped and fitted that all the core-maker had to do was to drop them in their places and ram round them. He had often wondered why girls were not more generally employed in this class of work, because, from what he had heard of girl core-makers, they were far more skilful than their brothers in work requiring deftness of touch.

Discussion.

Mr. F. Penlington, in opening the discussion which followed, said that in his opinion the reason why the machine had come to stop was to be found in the monotony of the work done in the bulk of their workshops. To-day there was more specialisation than ever. The ever-changing of patterns and sizes was naturally costly and foundrymen found it cheaper to specialise on certain classes of goods, and in some cases in a certain size of one certain class. A skilled craftsman would accept a situation at such a shop, if he fell out of work, in order to gain experience; but on gaining that experience would go elsewhere to break the monotony and get still further experience. He could not altogether agree with Mr. Key that the greater utilisation of unskilled men would benefit apprentices or craftsmen to the extent indicated. No craftsman would allow an apprentice to take a special part in the finishing work on an intricate job for some time, because it might result in the work of several men being spoiled. Before putting his hand to any but unskilled work the apprentice must gain some knowledge by using his eyes and brains. The extent to which unskilled labour could be used was dependent on local circumstances and the nature of the work. The question of hand versus machine ramming was very controversial, so much depending on the class of work. One of the chief questions raised by the Paper was—"What is an unskilled workman?" His own contention was that once a labourer was made into a bed-man, for instance, he became a skilled and not an unskilled man, and realising his increased value, would demand higher wages; and if these were not given he would go elsewhere. In his view it was all a matter of putting each man to the job he could best do, irrespective of whether he was supposed to be a craftsman or labourer, and pay him accordingly.

Mr. J. F. Atkinson pointed out that in many cases unskilled labour was the highest paid. In some foundries, for instance, labourers were used for binding down, but years must pass before they would be able to do that. Often a binding-down man got a few shillings a week more than a moulder; and the same was true of the tackle maker; in fact, the foreman sometimes took on the tackle-making. In considering the training of unskilled men, too, they must not forget the loss sustained through the bad ones.

Mr. Peter Walker said the moulder's duty was to see a job right through to the casting. A labourer might fill in, though even in that he sometimes "let one in." He had seen something of the lamentable results of setting labourers to cast moulds.

Mr. Hogg (Radcliffe) said that if all skilled men would do their best and make the most out of a machine or plate pattern, foundrymen would not have the grievances that existed to-day, and there would not arise such questions as this of bringing in unskilled men.

Cobalt and its Possibilities.

At a recent joint meeting of the New York sections of the American Electrochemical Society, the American Chemical Society and the Society of Chemical Industry, held in New York, Professor Charles Baskerville put before the meeting the following general statements regarding the investigations concerning the metal cobalt, conducted under the auspices of the Canadian Department of Mines.

The preparation of black cobalt oxide, CO_3O_4, from Ontario silver-cobalt ores, has been worked out and is at present extensively practised at the Canadian smelters; therefore, this oxide was taken as the raw material for these investigations.

Metallic cobalt, of a very high degree of purity, may be made from this oxide by reduction with carbon, with carbon monoxide gas, with hydrogen gas, or with aluminium; the former three at such temperatures as to make it commercially attractive and economical.

Metallic cobalt is not so closely identical with nickel in its properties as has been commonly considered.

Cobalt is considerably harder than nickel, being about 125 on the Brinell scale of hardness, whereas nickel is about 65 on the same scale.

Cobalt up to about 15 per cent., alloyed with steel containing small percentages of chromium and tungsten or molybdenum, yields alloys of extreme hardness, and of very high cutting qualities when used as high-speed tool steels. Nickel substituted for cobalt in these alloys does not in any case give the same results.

The melting point of pure cobalt we find to be 1,467 deg. C., to within 5 deg., whereas that of nickel is 1,435 deg. C. Therefore, so far as its melting point is concerned, cobalt is not very much more difficult than nickel to alloy.

Pure cobalt has a higher tensile and compressive strength than any of the pure metals with which the writer is familiar. The effect of cobalt on the tensile and compressive strength of certain alloys and steels is being studied.

Cobalt is magnetic at all temperatures up to about 1,100 deg. C. We have found an alloy of cobalt and iron, approximately Fe_2Co, which has a magnetic permeability in strong magnetic fields about 10 per cent. higher than the best Swedish soft iron. This has been independently discovered at this laboratory and by P. Weiss, Zürich, Switzerland.

Cobalt alloys with chromium and the resulting cochrome may be swaged to form wires, which are in some respects superior to nichrome wires as heating elements; they are less readily oxidised at high temperatures, and have a higher melting point. The thermo-electric properties of cochrome are being studied.

Small percentages of cobalt added to pure iron give alloys which are extremely non-corrosive and which will probably find extended use as sheet-roofing materials. These are at present being tested on a commercial scale.

Cobalt when electro-plated on steel and brass gives a more adhesive plate with a more silvery appearance than nickel. It seems to be less readily corroded than nickel under ordinary atmospheric conditions and upon handling.

Cobalt will probably find extended use in the plating industries for special purposes, even at a much higher price than nickel, in that it may be plated with extreme satisfaction from a more concentrated solution than nickel, and at a much higher current density. Cobalt can be deposited several times as rapidly as nickel.

The Production of Small Sound Ingots.

The following particulars relating to the production of absolutely sound ingots are taken from an article by Mr. Leslie E. Howard of the Simonds Manufacturing Company, Lockport, N.Y., U.S.A., published recently in "The Iron Age." Some years ago experiments were begun by the author's Company with a view of developing a method of procuring sound ingots especially for the manuafcture of saws. It was found by investigation that practically no fluid compression plants were in operation, working on ingots of much less than a ton in weight. At the present time, at the steel plant of the Simonds Company at Lockport, eight presses are in continuous operation, making ingots ranging from 180 lbs. up to and including 600 lbs. in weight.

Fig. 1 shows the general arangement of presses for handling ingots up to 1½ or 2 tons and as small as may be desired, and as many of these presses as are necessary for a given output are arranged side by side, supported in any suitable way, dependent on local conditions. An extension of the back end of the press serves as a support for a working platform which is made continuous from press to press, this working platform on the smaller size presses being approximately 3 ft. wide and the length of course varying with the number of presses making up the installation. This is shown quite plainly in Fig 3, which also gives a good idea of the valve control stands and the ingot racks. It will be noticed

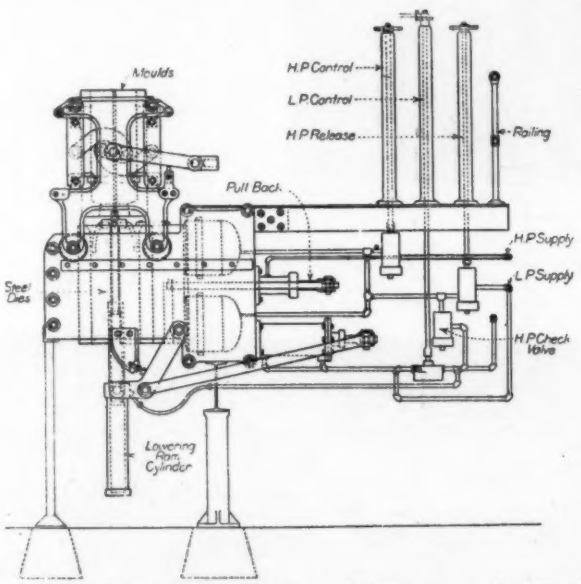


Fig. 1.—General Arrangement of Machine.

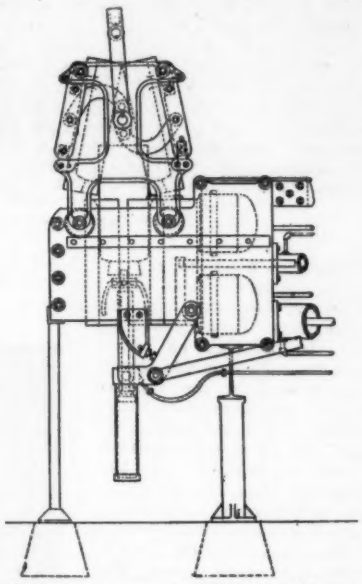


Fig. 2.—Fresh Ingot being Lowered into Press.

Machine for Compressing Small Steel Ingots.

It was found early in the experiments that it was quite out of the question to compress ingots in the same moulds in which they had been poured, chiefly for the reason that the mould cost and upkeep was too great. It was found that an ingot of approximately square cross-section could be operated on more satisfactorily than any other cross-section (excepting round or octagon), although ingots have been made satisfactorily by the process with a cross-section 4 × 8 in. and 8 × 12 in. and weighing respectively 350 and 600 lbs.

In a general way, the method consists of casting the ingots in moulds made of cast iron. While the ingots are still internally fluid but sufficiently set so that they will not burst by careful handling, they are transferred mechanically to steel compression dies where they receive lateral or side compression of from 1½ to 3 tons per sq. in. of greatest area of cross-section operated on, this pressure depending largely on the composition of the steel, temperature of the steel when poured, etc.

In this view that press No. 1 in the foreground is equipped with two moulds, whereas the rest of the presses are each equipped with one large mould.

In ingots up to the sizes mentioned above, and also up to and including 3,000 lbs., split moulds are found satisfactory and desirable, as they greatly facilitate the stripping operation, and on account of the very short time which the ingots are in the moulds there is an entire absence of warping and distorting of the moulds commonly met with in split moulds where the ingot is allowed to cool entirely in the moulds to a point where it usually is stripped.

It will be noted by referring to Fig. 1 that the press proper is of a box-like form or design. The hydraulic compressing cylinders form one end of the "box" and a heavy steel casting forms the other end. The mechanism for lowering the partly cooled ingots from the moulds into the compressing dies consists of a hydraulic cylinder and ram carried on

two swinging arms (one on each side of the press), so that it may be brought out of vertical alignment with the dies when desired and leave the pit under the dies absolutely clear and unobstructed.

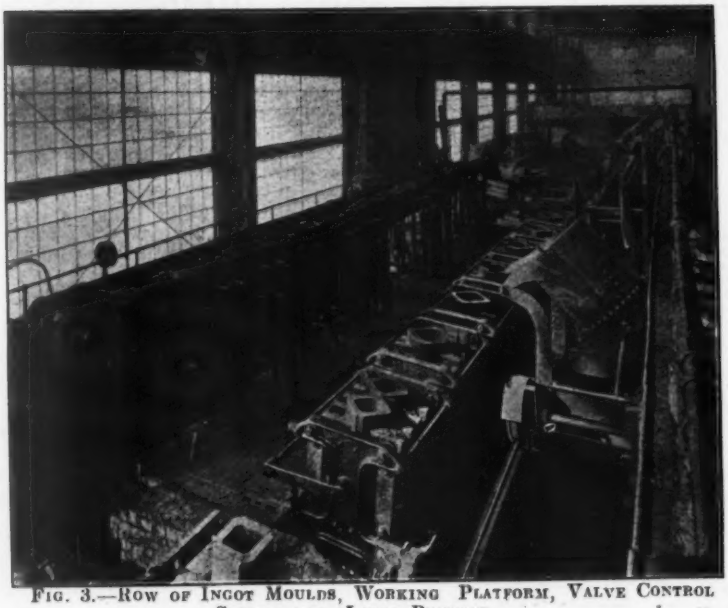


FIG. 3.—ROW OF INGOT MOULDS, WORKING PLATFORM, VALVE CONTROL STANDS, AND LADLE RUNWAY.

Mounted above the compressing dies is a mould-carrying rack, Fig. 1, showing clearly the principle on which this works. The moulds shown are split and in the smaller sizes this mould-carrying rack is operated by hand and in the larger sizes by a small hydraulic cylinder mounted on the side of the press frame, which is not shown in this drawing. Ingots of various cross-sections have been operated on by the regular equipment, but the present moulds and dies are designed and built for pressing the ingots cornerwise, that is, with one of their cross-section diagonals at right-angles and the other normal to the direction of the compressing; ingots of square cross-section have been found to work out better, not only from the compression standpoint but also for subsequent operations in the mills.

The bottom of the split mould referred to is formed partly by a removable round taper block, carried on the lowering ram and so arranged that when the moulds are "set up" this lowering ram is in its uppermost position, and the taper block forms a bottom closure to prevent steel from running through the bottom of the mould. It is found that these blocks or mould bottoms take practically all the wear of the mould, such as the cutting effect of the stream of molten metal when pouring, and they are practically the only parts that have to be renewed under seven or eight months; they ordinarily last, when running night and day on one 30-pot furnace, from two to three months.

Method of Operation of the Plant.

The moulds (having been previously well smoked without removing from the racks) are locked together by the toggle arrangement shown in Figs. 1 and 2, and the lowering plunger is brought to its uppermost position, so that the bottom of the mould is closed by the taper block referred to. The controlling valve on the high-pressure cylinder is, of course, closed and the discharge valve open, and the dies are thus opened to a predetermined point. The moulds are now poured by any approved pouring device, but at the plant described by a top-pouring ladle hydraulically operated, as in Fig. 4. After pouring, the ingots are allowed to set a predetermined length of time, depending on the size of the ingot, composition of steel, etc., but in any event just as short a time as is necessary to form a light skin which will not burst open when the ingots are stripped. The time varies from one to five minutes

FIG. 4.—MOULD RACKS, SHOWING METHOD OF CASTING INGOTS FROM HYDRAULICALLY-OPERATED TOP-POURING LADLE.

on ingots from 150 to 600 lbs. in weight and of various composition.

The stripping mechanism is now operated so that the moulds occupy the position shown in Fig. 2 (which shows the ingot partly descended into the dies), leaving the ingot supported at the top end by the moulds (which are not opened much, if any, at their top ends) and by the tapered block at the bottom end, which forms the bottom closure of the mould during the pouring. The low-pressure controlling valve handle is now moved one notch, causing the ingot to descend into the compressing dies, the speed of this descent being controlled by a stop-cock in the discharge line. The lowering cylinder is provided at its lower end with a spring, or in some cases with a hydraulic stop, so that the ingots are brought to rest very gently and in a position suitable for the pressing dies to operate on them. The high-pressure release valve is now closed and the low-pressure controlling valve handle is moved to the next notch and low-pressure water is thus caused to flow from the low-pressure supply through a high-pressure check valve into the high-pressure compressing cylinders, and the compressing dies are thus rapidly moved up to and in contact with the ingots and the cylinders filled with water under low pressure, usually 100 to 125 lbs.

The high-pressure controlling valve is then opened very slightly and compression is commenced. At this point the ingots are still fluid internally and have not begun to show the slightest sign of pipe or sinking in the top end. The compressing cylinders are allowed to come up very slowly indeed, so as to just keep the ingots from forming pipe, and this is continued until by experience it is known that the ingot is very near the point of setting or becoming solid throughout, when the pressure is increased slightly, and a small amount of the last portion of the ingot to cool is squeezed out of the top. This, of course, is the liquidated portion containing practically all the segregation and is decidedly higher in phosphorus, sulphur, and other impurities. This liquidated portion forms a rough ball-like knob on the top end of the ingot, and is practically the only portion of the ingot not suitable for finishing; in weight it varies from 2½ to 4 per cent. of the total weight of the ingot.

As soon as the compressing dies have a good grip on the ingots so that there is no possible danger of their dropping through into the pit, the low-pressure controlling valve handle is moved to the fourth notch, causing the low-pressure cylinder to move the ingot-lowering cylinder out of vertical alignment with the compressing dies, and the controlling valve is then left in this position until compression is completed. The pressure is kept on the ingot for a considerable time after it has ceased to "rise"; in fact, after it has reached the point where it is considered solid, the pressure is quite materially increased, and the ingots then receive what is virtually a hydraulic forging treatment, which tends to break up the coarse crystals formed in cooling into a fine crystalline structure much resembling an ingot worked under a hammer or forging press.

The total operation of setting up eight presses occupies but 10 or 12 minutes, the greater part of which is used in smoking the moulds. One man easily operates eight presses, and the presses are so designed that they may take care of two to three furnaces (in the plant described these being 30-pot crucible furnaces), providing all the furnaces are running on the same size of ingots, so that it is not necessary to change the moulds and dies between the heats. The presses are amply provided with cooling facilities so that the parts do not become overheated .

Heat Treatment in Steel Castings.

In a Paper submitted at the recent meeting of the American Institute of Mining Engineers, by Messrs. C. D. Young, O. D. A. Pease, and C. H. Strand, it is stated that in an effort to employ cast steel of a stronger structure than that found in the annealed steel castings, the possibilities of heat treatment which will increase the strength without materially decreasing the ductility may be resorted to. The authors give a brief outline of what has already been done by the Pennsylvania Railroad Company at its shops and test laboratories at Altoona, Pa. The account is of material interest, as it indicates what may be done with steel castings when properly treated, thereby permitting in railway service greater strength of cast-steel parts without any increase in weight or space. The obscurity formerly surrounding the heat treatment of steel has been for the most part removed by the development of our knowledge of the critical points of steel, pyrometers, furnace construction, and the testing of the finished product. The operations of the heat treatment proper are taken up under the heads of (1) heating for quenching; (2) quenching; (3) drawing.

(1) *Heating for Quenching.*—Heating for quenching is best conducted slowly, especially in the case of castings of variable thickness. Cracks may occur either in heating or in cooling, due to different temperatures at different points of the casting. The castings should be thoroughly soaked at the maximum temperature (generally 1,500 deg. to 1,600 deg. F.), one hour being sufficient for sections 1 ft. in thickness. The minimum temperature which will produce the desired hardening effect will in all cases be found to be the most satisfactory, as the grain coarsens when the critical range is exceeded to too great an extent. All temperatures should be governed by a checked pyrometer with the hot junction to the heated object, and with several couples in a large furnace to ensure a uniform temperature.

(2) *The Quenching Operation.*—The casting should be transferred as quickly as possible from the furnace to the quenching bath, and in the case of large castings, such as locomotive frames, this is by no means a simple matter. The largest castings are best handled by means of cranes and rollers.

The quenching agent employed is generally water or oil, preferably the former, because of its cheapness and drastic cooling effect, more readily breaking up the coarse cast-steel grain. With intricate castings it is generally best to use oil. With water it is possible to have a large tank and a large running stream, serving to maintain a uniform temperature. Castings should never be thrown in to rest on the bottom of the tank, but should be agitated to prevent the formation of a coating of vapour, retarding the quenching effect. It is also best, whenever possible, to quench the thicker portions first.

(3) *The Drawing Operation.*—Whenever possible, the drawing should be done in a bath of some kind, such as lead, barium chloride, a barium chloride-salt mixture, or oil. In the case of large castings this is manifestly impossible, and great care should be exercised in obtaining a uniform temperature in the drawing furnace. The use to which the casting is to be put determines the drawing temperature, railroad work, by reason of the shock and vibration of the road, requiring high ductility at the sacrifice of some strength.

From the average results of a considerable number of tensile tests made from large castings, it appears that the heat treatment increases the elastic limit about 50 per cent. and the ultimate strength about 25 per cent., without any material change in elongation.

Physical Properties and Chemical Composition of Coke.*

Coke varies greatly in its external appearance, physical properties, and chemical composition. In external appearance it may be dull grey, light grey, light grey and silvery, or, as generally expressed, "of metallic lustre" when coated with deposited carbon, or black; occasionally it is iridescent. It generally has a rough surface, but that part of the charge near the walls of the oven is often smooth and glassy. Sometimes hairlike threads are observed on the surface of ordinary coke. This "coke-hair," like the "metallic lustre," is due to deposition of carbon from the heavier hydrocarbons given off at lower temperatures. The process of deposition is described by Percy as follows:—"A bubble of tarry or hydrocarbon vapour and gas, in escaping from the surface of the coke, becomes more highly heated, and is in consequence decomposed with the separation of solid carbon, which is deposited as a continuous coherent film on the surface of the bubble; a second bubble escapes through the carbonaceous shell of the first and is similarly decomposed, forming a second carbonaceous shell attached to that resulting from the first bubble; and so on by succession of such deposits of carbon a continuous tube is formed. Gas would continue to flow through this tube, depositing carbon in its course on the inner surface, until at length the tube is converted into a nearly solid fibre."

Colour.

The colour of coke may be due to the nature of the coal from which it is made, to the temperature during the coking process and the time of its application, to watering the coke, whether inside or outside the oven or in an open or closed receptacle, and perhaps to other factors. The watering of by-product coke on the wharves or in different style cars, exposed to the air during quenching, blackens the coke and adds an excessive amount of water. Where by-product coke is watered in closed receptacles the silvery-grey colour is preserved and the percentage of water is comparable with that in the beehive product. The colour of coke, however, is by no means a safe criterion of its adaptability to the work to be done. The trouble formerly experienced by by-product coke-makers in getting a trial for their product in the blast furnaces is an illustration of the suspicion in which by-product coke was held. The coke was condemned without trial because of its dark, dull, dirty appearance. Subsequent experience has disproved the old idea that beehive coke is the best metallurgical fuel.

Physical Structure.

In physical structure coke may be porous and light, or dense and heavy; it may be soft or hard and capable of sustaining heavy load and not easily crushed in metallurgical operations or in transportation, or it may be brittle, whether hard or soft, with a tendency to break up easily into small pieces. When sharply struck it gives a clear, ringing sound, in some specimens almost like tempered steel, or, if soft and punky, it gives a dull, heavy sound. The ease with which coke ignites and enters into combustion also varies greatly.

The terms light and heavy refer to the specific weight of the coke. Dense is opposed to porous. The less the cell space the more dense is the coke and the greater the cell space the more porous is the coke. The size of cells does not determine the porosity of the coke; thus, visual examination of a coke may show that it possesses small cells, while determination of the percentage of cells by volume will show that the cell space is exceedingly large; in like manner, the cell structure of a coke may be large but the percentage of cells by volume may be small. The terms dense and hard, soft and porous, must not be confused; hardness and softness refer to strength of the cell walls of the coke, density and porosity to cell space. Generally speaking, dense cokes are also soft and punky, and porous cokes, unless the cells be unduly enlarged, are hard. This, however, does not always follow. Some of the best cokes, capable of withstanding the work of any modern metallurgical operation, are dense and hard, and in some processes, especially where permeation of gases is not a chief factor, density combined with strength is a desideratum.

Numerous experiments as to the relative value of charcoal, anthracite, and coke have demonstrated that it is this cellular structure which gives to coke its great advantage as a metallurgical fuel, and for this reason it may be stated that within certain limits, other things being equal, the more porous the coke the better it is as fuel. There is, of course, a limit to the advantage gained by this porosity, and this limit is reached when the cells are developed to such an extent that the cell walls are weakened, so that coke crushes in the furnace. A further increase in the size of the pores is, of course, injurious. The porosity of coke depends on the nature of coal from which it is made, the washing of the coal, the fineness of crushing, the tamping and compacting in charging, the process of making, the kind of oven used, the depth of charge, the temperature of coking, and the length of time applied. There may be other factors, but the foregoing are, in the main, the controlling or determining ones.

Porosity.—All coke is more or less porous. In some instances cells may be entirely enclosed, not communicating with other cells, but generally coke is permeated by a complicated system of intercommunicating pores.

Specific Gravity.—The determination of the real specific gravity, or the specific gravity of the coke substance, is made on a finely ground sample by the usual methods.

The apparent specific gravity or the relation between the whole mass of material and an equal volume of water, is generally determined on 1-in. cubes as first suggested by Hunt and later improved by Dewey. Dewey selected representative specimens weighing from 20 to 40 grammes, dried them at 100 deg. C., and determined the weight of the dry coke. He soaked these samples in water from 12 to 24 hours, then placed them under the receiver of an air pump and exhausted the air as completely as possible; this operation he repeated several times in order to insure replacement of air by water. The thoroughly saturated specimens were weighed first in water and then in air and calculation made as follows: The loss in weight in water of the saturated material, less the weight of water absorbed, divided by the weight of the dry material, gives the apparent specific gravity. The many objections raised to this method, due to the difficulty of preparing 1-in.

* Abstracted from Technical Paper 50, by A. W. Belden, issued by the United States Bureau of Mines.

cubes, the uncertainty in completely filling the pores and in subsequently drying the exterior without abstracting water from the pores, and the loss of weight during weighing, due to evaporation of water, led to the development of a method by the chemical laboratory of the United States Bureau of Mines as outlined below. The special apparatus is shown in Fig. 1. This apparatus is so calibrated that 500 grammes will sink it in the water to the middle of the spindle just above the float. Pieces of coke 2½ to 3 in. in diameter are placed on the large pan, a small piece or two being added, if necessary, to bring the water to the right mark. The apparatus is then taken out of the water and the coke is transferred from the pan to the basket, then immersed again, and weights are placed on the small pan until the water again reaches the mark. The weight of the sample in air divided by the loss of weight of the sample in water gives the apparent specific gravity.

The percentage of coke substance by volume is determined by dividing the apparent specific gravity by the real specific gravity.

The percentage of cells by volume is determined by subtracting the apparent specific gravity from the real specific gravity and dividing the difference by the real specific gravity.

The volume of cells in 100 parts by weight is obtained by dividing the percentage of cells by volume by the apparent specific gravity.

Size.

Modern practice no longer demands coke in large, long pieces, but coke of a uniform size. The action of blast furnaces and cupolas is more regular and uniform if coke of uniform size is used. The author has been unable to ascertain whether any furnace plant reduces coke to uniform size by crushing, but he is inclined to believe that, in spite of the added cost and attendant loss due to fine coke, crushing would still prove economical by reason of the better working of the furnace, the prevention of slips and scaffolds, and the uniformity of the metal produced. The size to which coke should be crushed is a matter for determination by experiment.

Shatter Test.

The relative breakage of all cokes made in the investigations conducted by the Bureau of Mines is determined by the shatter test. This test, which can be varied to suit individual requirements, consists in dropping a definite weight of coke on an iron plate from a height of 6 ft. The number of times dropped, whether the coke should be screened between successive drops, and, other factors, can be varied to suit individual needs. The Bureau of Mines, in order to make all its tests comparable, has adopted the following apparatus and method :—

The apparatus for making the test consists of a supported box capable of holding 100 lbs. of coke, the bottom of the box being 6 ft. above a cast-iron plate. The doors on the bottom are so hinged and latched that they will swing freely when opened and will not impede the fall of the coke. Boards about 8 in. high are placed around the iron plate so that no coke may be lost. With a coke fork a sample of approximately 50 lbs. is placed in the box, no attempt being made to arrange it therein. The entire contents of the box is dropped four times on the iron plate, the small material and the dust being returned each time with the large coke. After the fourth drop the material is screened on a screen of 2-in. mesh; the coke that remains on the screen and what passes through are weighed and the breakage is determined. If the sum of the weights indicates a loss of over 1 per cent. the test is rejected and a new one made.

Compressive Strength.

The question of obtaining the true compressive strength of coke by means of 1-in. cubes has received much attention from various investigators. The comparison between cokes made from the same coal in different types of ovens, or even in ovens of the same plant, or the comparison of cokes in general by means of the results of compressive strength tests is difficult if not impossible. The inability to select a cube, or any number of cubes, to represent anything more than the piece from which it is taken has been demonstrated by experiments conducted at the United States fuel-testing plant. About 800 cubes taken from 174 tests of 94 coals from all parts of the country, representing as nearly as possible comparable and representative samples of the different cokes and those from the same portion of the oven, were tested for compressive strength. The variations in the results, even in cubes of the same coke from one oven, to say nothing of cubes from different ovens, were in all instances so great as to preclude the drawing of any conclusion other than the worthlessness of attempting such comparison. Other cubes were selected that represented each inch of the whole height of the coke in the oven and an attempt was made to obtain an average from the compressive strength of the individual pieces. Results from this procedure were also shown to represent nothing but the piece of coke from which the cubes were cut. Similar cubes from pieces on either side of the first, as well as from different parts of the oven, showed no uniformity either individually or on an average. The condition and the burning of the oven, the quenching either inside or out, and any number of factors of which we have no knowledge and cannot control cause great variation in the coke from different parts of the same oven. The prime consideration is the probable breakage of the coke during its descent in the furnace or cupola, where many other factors than compressive strength have to be considered, such as the action of gases and high temperatures, and the attrition of coke against coke and other constituents of the burden and against the walls of the furnace. The breakage of the best coke on handling and in transportation is a considerable item, and in cokes of poorer quality the importance of this item increases in proportion as the friability increases.

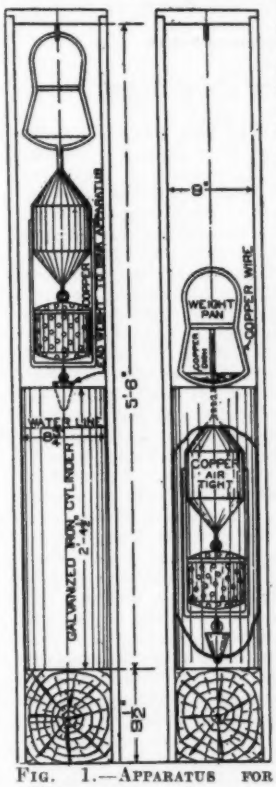


FIG. 1.—APPARATUS FOR DETERMINING APPARENT SPECIFIC GRAVITY.

Attempts have been made to use the compressive strength of a coke for calculating the height of furnace burden that the coke is capable of sustaining. This practice is not warranted, as the following simple statement will show :—One cub. ft. of coke weighs approximately 28 lbs.; 1 cub. ft. of ore and flux weighs approximately 115 lbs. If the charge is mixed in the approximate proportion of 3 parts by weight of ore and flux to 1 part by weight of coke, then

28 lbs. coke.	= 1.00 cub. ft.
86 lbs. ore and flux	= 0.75 cub. ft.
114 lbs. charge.	= 1.75 cub. ft.

One cubic foot of charge therefore weighs 65 lbs. Let it be assumed that the weight of the charge is evenly borne and that the height of the furnace is 95 ft., then the weight on each square foot at the base is 65 multiplied by 95, or 6,175 lbs. per square foot, or about 43 lbs. per square inch. Even the poorest cokes would doubtless show a crushing strength much in excess of this figure.

Discussion on Cast Iron.

Before a recent meeting of the Newcastle-upon-Tyne Branch of the British Foundrymen's Association, Mr. F. J. Cook, of Birmingham, in the course of a lecture on "The Physical Properties of Cast Iron," said that it was not so very long ago since the only method adopted by foundrymen for judging the physical properties of cast iron was by the ease with which castings were broken, and the structure of a broken surface. Although that might be considered to be a somewhat crude method, there were observant foundrymen who, on that basis, produced good castings. It should also be remembered that they were helped considerably by the fact that pig-irons in those days were chiefly made from local ores, which were melted in slow-running furnaces with cold or semi-cold blast, and were thus possessed of quite distinct characteristics for each district. About twenty-seven years ago Professor Turner first published his researches on the influence of silicon on cast iron. Later there arose a school of men who considered that chemical analysis was the panacea for everything in connection with cast iron. That fallacy remained for quite a long time, but it had begun to be recognised that chemical analysis was only one of the important features in the production of sound and strong castings. Chemical analysis must of necessity be the foundation of all scientific working, but other things had to be taken into consideration if the best physical results were to be obtained. Generally speaking, with the same chemical analysis the same results might be expected, but in some cases that did not happen. An example of this was witnessed in a Swedish works by Dr. T. Swinden. The furnace was producing 40 tons of pig-iron a week, and when an attempt was made to increase the output by having a higher temperature and more rapid working, the same chemical analysis was got, but the properties of the metal were totally different.

The Branch-President (Mr. R. Wallis), referring to the network structure which characterised a strong iron, said he took it that cold-blast irons showed that structure, to which Mr. Cook assented.

Mr. J. Smith, referring to the same point, asked whether the cold-blast pig-iron of earlier times was characterised by the network structure in question.

Mr. Cook replied in the affirmative, and said he had a piece of iron made in Watt's time which contained that structure.

Mr. J. Smith said that Mr. Cook had intimated that the influence of increased blast pressure was to harden the iron; as the iron increased in hardness, was it increased in strength? With a higher silicon increased blast pressure might give better results.

Mr. Cook replied that that was so. The hardness and strength would vary according to the size of the cupola, and also the class of iron.

Mr. Smith commented on the low manganese content of certain irons which the lecturer had discussed.

Mr. Cook, in reply, said he was a believer in low manganese for high tensile-test results, and also to withstand heavy pressure. He was rather antagonistic to some people because he believed in high sulphur and low manganese. By high sulphur he meant about 1.2 per cent. He had had many instances of defective cylinders which showed low sulphur and high manganese.

Mr. Weir said he had had many instances where hard iron had been made soft by increasing the coke in the cupola.

Mr. Cook replied that that would be because the iron was deficient in total carbon; with the excess of coke it took up carbon from the coke.

INDUSTRIAL USES OF COAL GAS.—Lecturing at Newcastle-on-Tyne recently on this subject, Mr. H. M. Thornton observed that manufacturers of high-class steel were being increasingly requested to quote for it in the annealed condition. By the older method, with solid fuel, the operation occupied from three to five days, the most that could be done being two heats per week. But a great saving of time and cost, not to mention the improvement in annealing, had been achieved by means of the Richmond gas-heated regenerative natural-draught oven furnace. These gas furnaces would anneal ordinary carbon and high-speed steel, in charges of 2 tons and upwards of bar steel, in forty-eight hours from start to finish, using town's gas as fuel—the steel bars being simply placed on the firebrick floor of the gas oven. The heating was accomplished by a number of special gas burners. The following figures from actual working were given :—

Annealing Steel in Regenerative Gas Oven Furnace.

	Carbon steel.	High-speed steel.
Weight of charge	35 cwts.	45 cwts.
Total time of heating	6 hours	9 hours
Time of cooling	42 ,,	40 ,,
Total time of operation	48 ,,	49 ,,
Maximum temperature attained	880° C.	875° C.
Gas consumption per ton of steel	3,600 cub. ft.	5,000 cub. ft.
Cost of gas per ton of steel annealed, on the Newcastle Gas Company's industrial tariff	5s. 7½d.	7s. 9d.

Mr. Thornton also gave the results of a melting test recently made with a Richmond crucible furnace, worked with gas and air blast, with preheating chambers over the crucible, the results being as follows :—

Melting Test with Crucible Furnace.

Capacity of crucible	60 lbs.
Time employed to heat to working temperature	25 minutes.
(a) 60 lbs. of gun-metal scrap placed in hot furnace, melted in	21 minutes.
Gas consumption for melting	95 cub. ft.
(b) 60 lbs. of large awkward gun-metal scrap melted in	32 minutes.
Gas consumption for melting	135 cub. ft.
(c) 60 lbs. of light brass scrap melted in	29 minutes.
Gas consumption for melting	100 cub. ft.

Jobbing Pulley Moulding.

By Joseph Horner.

Notwithstanding the arguments in favour of pulleys of wrought iron and of wood, cast iron is so largely used that numerous moulding machines are designed for dealing with this class of work exclusively. The following describes the making of plain, solid cast pulleys, and of pulleys split through the boss and rim, as made in the ordinary jobbing shops without assistance from moulding machines.

Pulley patterns are rarely made of wood, because this is too flimsy for permanent service. They may be so made for occasional odd sizes, or to cast iron patterns from, in which case they are built up with segments, thin, rather than thick. Arms are constructed of wood locked at the centre and let into the rim, which is divided in the plane of the centre. But such patterns, even though well built, will not endure even moderately long service unless they are mounted permanently on a middle plate, or each half on a separate plate. For all permanent and standard use, pulley patterns must be of iron, the rims being turned inside and out and the arms filed smooth. But here difficulties arise consequent on the enormous stock of patterns which is required in a manufacturing shop, where they must advance by ¼ in. from, say, 6 in. up to 24 in. diameter and thence by inches up to 108 or 120 in. in the usual limit of sizes which are stocked. Besides this, pulleys vary in width from 3 in. to 24 in. Some again have crowning or convexity, others none. The narrow pulleys have single arms, the wide ones double sets of arms. The larger pulleys frequently have alternatively arms of light and of heavy section. A wide pulley with crowning, or one carrying a double belt, is wanted of heavier build than a narrower one with a straight face, or than one for a single belt.

Double arms are not desirable for average widths, even though these are heavy. A lesson taught by pulley casting is that arms, rim, and boss must all be properly proportioned to avoid unsafe shrinkage strains. Again, the largest pulleys frequently have arms with double curves while the smaller ones have single curves only, and the smallest of all may have solid-plated centres, as when the boss being of large diameter leaves no room for arms. Bosses, moreover, have to be of different bores and lengths, and some have keyway bosses while others running loose have none. So that all bosses must be interchangeable in different pulleys. Many pulleys, too, have to be split; separate patterns are not made for these. Except for the splitting lugs and prints, the proportions of split pulleys are the same as for whole ones, so that the latter are utilised, except for the addition of the necessary lugs. Flanges are sometimes cast around the edges of pulleys or in the central plane. So that the problem of standardising pulleys in a large range of dimensions is far from being a simple one. To make rigid, complete patterns for every different size in the range is very costly. A few which are regularly called for may be so constructed, but in general the better plan is to adopt a sectional method of construction.

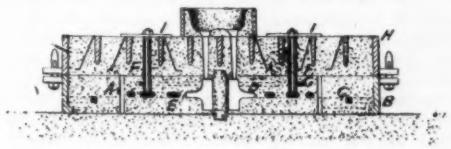


Fig. 1.

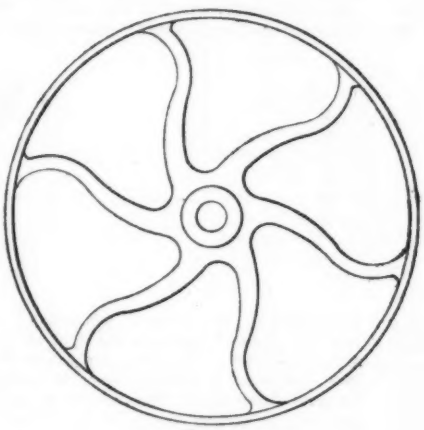


Fig. 3.

Fig. 2.

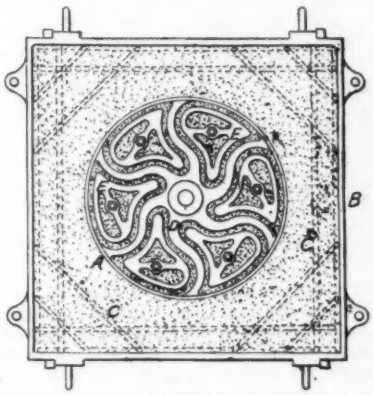


Fig. 4.

The system here described is one with which the writer was identified for a good many years in a shop where large numbers of pulleys were made. In this system the pattern comprises an iron ring and separate loose arms. Plain rings of cast iron are turned and bored for every size of pulley likely to be ordered, advancing in diameters by the measurements required, plus turning allowances. The pattern rings range in depth from 12 in. in the smaller, 16 in. in the medium sizes, and 20 in. or 24 in. in the largest. If an extensive business is being done in pulleys, two such sets of rings will be wanted, one thicker than the other, the thicker one being used for pulleys, the faces of which have to be turned with crowning, and which are of exceptional depth. Since the pattern rings are of definite widths, when shal-

lower pulleys are required they are made from these by strickling down, and deeper ones by drawing. When one set of pattern rings only is made, it should be of the lighter metal, and thicker pulleys be moulded by putting thickness strips around and strickling off the sand by them, which is not, however, a good method to adopt. The arms which fit within the rings are destitute of bosses but have a hole bored in the centre for the purpose of studding on bosses of any required size. Two sets of arms are also made, one light, and of oval section simply, Fig. 1, another of slightly heavier section and ribbed, Fig. 2.

A large stock of wooden bosses is made at an early stage. They are prepared as required, and soon accumulate in the stores, so that in course of time bosses of all diameters and depths can be selected. They all fit interchangeably to all arms with a stud of one size, say 1½ in. The core prints are also all fitted with studs to the bosses, so that variations in bores can be readily made.

Take first the case of an ordinary plain pulley of, say, 2 ft. diameter, using a pattern ring to mould from, and a set of loose arms. First the ring is moulded by bedding-in. If a solid pattern is divided through the middle plane, each half with its half thickness of arms, the turn-over method is adopted, one-half going in the bottom the other in the top. But having an unjointed iron rim, and loose arms also unjointed, bedding-in is adopted. The disadvantage of the lift in this case is apparent. There is no

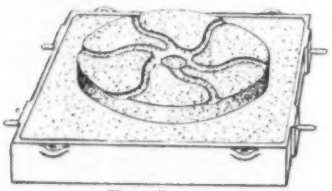


Fig. 5.

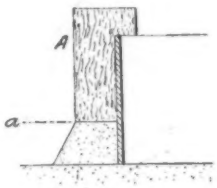


Fig. 6.

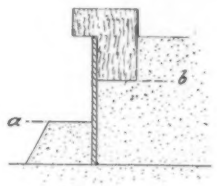


Fig. 7.

upward taper on the inside of the rim, so that the sand becomes broken away around the edges, and the mass in the centre, which has to be entirely carried by lifters, is not safe. The larger in diameter and the deeper the pulley the greater is the risk of a fall-out of a portion or of the whole of the cope occurring. When a solid pattern, meaning by that one in which the rim and arms are in one, and unjointed, is used, this lift is unavoidable, and such patterns should have a little taper internally in the direction of the upward lift. For solid patterns, therefore, or for those with a turned rim and separate arms, in all sizes over about 18 in. or 2 ft., the assistance of grids or rings to carry the sand must be taken full advantage of. But the principal advantage of the method afforded by grids can only be secured when the arms are separate from the rim, as will be now explained. Taking as an example the pulley, Fig. 3, the method of proceeding is as follows:—

Making a level bed first, the pulley ring A, Fig. 4, is placed upon it as shown, and round it is laid an open middle part B, the depth of which will be selected most conveniently for the job in hand. If it is deeper than the pulley, the bed on which the latter rests must be strickled down and sloped away to form a joint face lower down for the box to rest on, in order that the top edge of the box shall come level with the top of the pulley. The pulley being laid on its bed, and parting sand strewn, and the middle part B placed around it, the rods C are arranged diagonally to fill up as much of the space as is required, for retaining the sand. Clay wash is daubed over the bars, sand is shovelled in both within and without, is strickled level on the outside of the pulley and to the centre of the arms within, and a hole is cut out for the boss. The arms D are then bedded-in with their bottom boss, the joint line just strickled being a guide for setting them level by. The sand is tucked around the boss and rammed with the pin rammer, and the whole of the joint face between the arms is pressed down and sleeked over with the trowel. Parting sand is now strewn on, and a layer of facing sand of about ¾ in. thick sieved over, and six grids E are bedded down upon it between the arms. The grids are furnished with screw bolts F cast in, and standing about a couple of inches above the top edges of the bars of the top box. More sand is shovelled in over the grids. It is often advantageous in large pulleys to still further bind the sand together by ramming up a ring between the grids and the top edge of the rim, as shown at G in the sectional view. The top boss is now rammed in place and the remaining sand rammed up to the top of the pulley rim, where it is strickled off level. Parting sand is strewn on, and the top part H put on and rammed.

The bolts from the grids pass up through the cope, clearance being made round them by enclosing them in pieces of tube stood up in the cope, and they are screwed against the flat plates I, I, that bear on the edges of the bars or stays. The cope is now lifted off, and the pattern ring is withdrawn. The cope is then lowered on the top sand again, and screwed thereto by means of the bolts F passing up from the grids, and the whole is now turned over (Fig. 5) and sleeked and blackened. The arms are taken from the bottom, and that also is sleeked and blackened, and the top lowered down again, the mould being ready for casting. It is poured and fed as shown in the upper view of Fig. 4.

The difference, therefore, between this method and the previous one is that instead of pulling the upper half of the sand away from a parallel rim, the rim is drawn up through its entire depth without fracture. But for this it is necessary that the arms be loose from the rim. Grids can be used with a solid pattern but, as stated, the interior of the rim should be tapered upwards, which method is not consistent with the stock system here described.

A top and bottom box part might be used in Fig. 4 if the bottom box had flat bars and depth enough to receive the mould. But to stop off, a middle part and a top will be necessary. In this case the ring is bedded-in lightly on the floor sand, and levelled with a spirit level laid on the top edge, and the sand is partially rammed within and without the pulley. Then with a strickle A, Fig. 6, sand is struck off level to the depth *a* required, 8 in., say, in this case, or 4 in. above the bottom edge of the pattern pulley rim. Afterwards the sand in the interior is made level with the centre, Fig. 7, *b*, of the 8-in. depth which has just been strickled outside, corresponding therefore with the centre of the arms, to be now bedded in, which is easily done because they are thin. The

middle box part is laid around the pulley rim with a parting sand joint on the face *a*. If a considerable number of castings of the same size are required it pays to make circular flasks with the minimum of sand space. For jobbing work the ordinary square flasks, well rodded and liftered may serve the purpose sufficiently well.

The outside middle is now rammed up level with the top edge of the pattern, parting sand is dusted over this top face, and inside the rim on the joint faces of the arms bedded in, the grids laid in as before, and the cope is put on. This must be well liftered, with lifters hanging from the top edges of the bars, and coming down inside the rim close to the joint face. A runner pin or git is put over the boss. The cope being rammed and lifted off has the same appearance as Fig. 5. The arms are now withdrawn and the pattern ring and the middle box part. Then the space left below the 8-in. strickled depth is filled up with sand, leaving only the finishing of the mould to be done. It is both poured and fed in the boss.

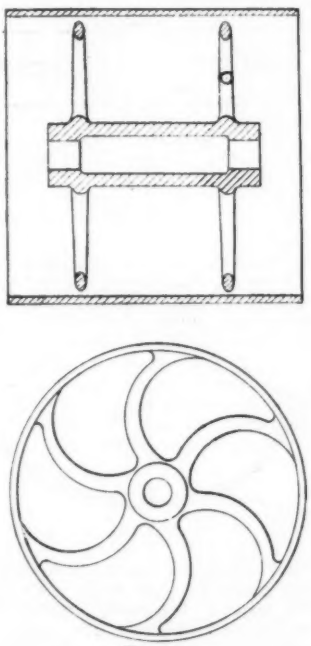


FIG. 8.

When a pattern is drawn to make a mould deeper than the pattern, the ramming up of the rim is done inside and outside, outside to the top, inside to the depth of the centre of the arms, which are bedded-in, and grids inserted. Then the rim is drawn up as for delivery as far as the added depth required, say 2 in., 4 in., or 6 in., and the ramming completed to the top edge. The top is then rammed as before, and liftered, and the delivery follows in the manner already stated.

Pulleys with Double Arms.

When pulleys are very wide on the face, a single set of arms does not afford sufficient support to the rim, and it becomes necessary to cast in two sets of arms. These are then usually connected and bound together with a central boss, though sometimes if the distance between the arms is very considerable, there is only a short internal boss on each arm, leaving a space between, but in each case the method of moulding is the same. Take now the moulding of the double-armed pulley, Fig. 8, as an example. The pulley can be made of the same depth as the pattern, or shallower, or deeper. Here we assume that the mould will be increased in depth by drawing, and that the pulley is of large dimensions.

First a bed, A, Fig. 9, is levelled with winding strips in the usual manner, and strewn with parting sand, and upon this the pulley ring B is laid. Middle parts will be selected as happen to come most convenient. Three are shown. These are rodded and swabbed, and the first one being laid down and staked, the ramming commences. The outside will be rammed up to the top edge of the flask and vented to the pattern. The inside will be rammed to the level of the first set of arms D, which will then be bedded down into it, together with their boss E, and print the sand between, the arms being sleeked approximately level with the centre plane of the arms. Parting sand is strewn over, and upon this is laid the grid which has to carry the central mass of sand, or that lying between the two sets of arms. This is really half a dozen separate grids, one to go between each arm, and all united by arched connecting rods passing from one to the other and cast in. The whole structure is lifted by means of the eyes seen, numbering either three or six, and cast in the grids.

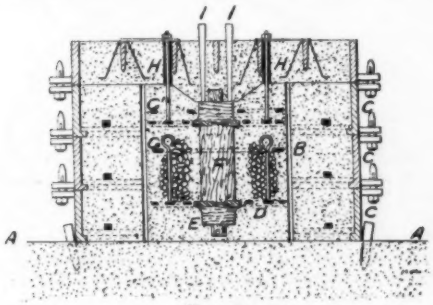


FIG. 9.

The grid being swabbed and bedded in place, and the boss put in, the ramming up proceeds above it.

The middle body of the mould is better made in dry sand to afford solidity, and the central portion of the core is formed with cinders, as shown, to assist in venting and also allow it to yield to the shrinkage of the thin ring, without which precaution it would be liable to fracture. Vents are carried to the sides and perpendicularly. At about half-way up a binding ring G is bedded in, and the ramming up is continued to the proper height for the top set of arms. The sand is brought up also around the outside until all the middles are put on and cottered together. If the pulley pattern is shallower than the depth required for the casting, as we suppose to be the case, it will at about this stage be drawn up through the mould to the required height. This may be safely done, as there will be sufficient body of sand beneath to resist crushing of the mould below by the subsequent ramming.

Having reached the proper height for the second set of arms, they are now bedded in, the joint face made as in the case of those below, and the top grid, similar also except that it has bolts instead of eyes, is bedded down, and the ramming is continued to the top joint, a binding ring G^1 being bedded in here as in the middle sand. Outside and inside sand being sleeked off level with the top edge of the pulley, and parting sand strewn, the cope is put on. The bolts

pass through pieces of tube to the top, the runner pins I I, are inserted, and the liftering and ramming are done as usual. The cope is then lifted, and the sand above the top arms is drawn up, then the middles are lifted away in one body, being cottered together, and the outer sand is sleeked and finished. The sand which forms the inside of the pulley is also sleeked, then the top arms are drawn out, and the boss, the middle mass of sand lifted by means of eyes and slung in the crane, and top and bottom arm moulds finished, the bottom arms and boss withdrawn, and that portion also finished. The mould is then put together piecemeal in the reverse order to which it was made.

Splitting.

There are two reasons why pulleys are split, first, for convenience of putting them on portions of shafts at places removed from the ends without the trouble of moving other pulleys out of their places, or of lifting the shaft from its bearings. Second, in cases when owing to disproportion between boss, arms and rim, risk of excessive shrinkage occurs which might cause fracture of the arms or rim. The pattern is commonly moulded entire, and the necessary division is made by interposing plates of metal in those positions in the mould where the divisions are to be

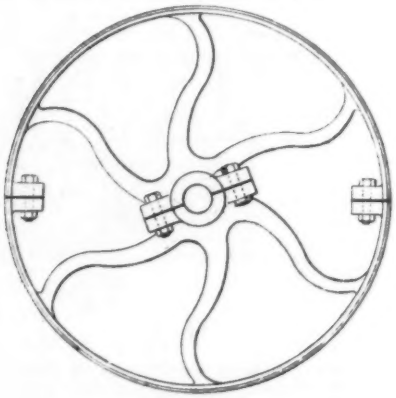


FIG. 10.

effected. One way is to cast divided lugs on the boss and rim, and bolt them together afterwards as in Figs. 10 and 11. The other is to divide the boss only, Fig. 12, and furnish it with grooves for the bonds which are afterwards shrunk on. The first is adopted when the pulley has to be divided for placing on a shaft in halves, the second when it is split as a precaution only against fracture.

Figs. 12, 13 and 14 show the provision required for splitting by the first method. In Figs. 13 and 14. A is a portion of the pulley rim, B is a block of wood forming the pattern for a single pair of lugs, C a print of the same thickness as the splitting plate. In the case of an iron ring pattern, two of these blocks are bedded in against the rim on opposite sides and there rammed up and withdrawn. The provision for splitting the boss, Fig. 15, is similar, A being the top boss, A^1 the bottom one, B, B^1 being lug blocks fitting around the bosses, and having prints C, C^1 fastened to them. The prints are shown differently at C and at C^1, C reaching to the top, C^1 being cut off level with the joint passing through the centre of the arms, the lug B^1 being similarly divided across the centre. These represent two different methods of moulding, either of which may be adopted according to circumstances. At C where the print comes up to the top of the lug B and the boss A, and that portion of the lug and print belonging to it comes up in the cope, it is evident that when the splitting plate is put in the mould that portion which lies above the central line of the ribs must pass also into the cope. Then if the cope is lowered down upon it the plate will hardly pass into the narrow print above without pushing down some of the sand, in spite of good fitting pins to the boxes and careful lowering. Hence the reason for cutting the print down to the joint D as at C^1. So that while the plate is supported by the print, its upper portion will fall within the lug, having no print impression to pass into. But again in deep bosses it is not safe to trust to the bottom print alone. Then two courses are open, one being to bed a couple of chaplet nails into the sand at the sides of the lugs, letting the heads touch the sides of the plate, and so keep it in position, or to retain the deep prints C and lower the splitting plate into them when the mould is closed at the joint of the arms, but immediately before the cope is lowered.

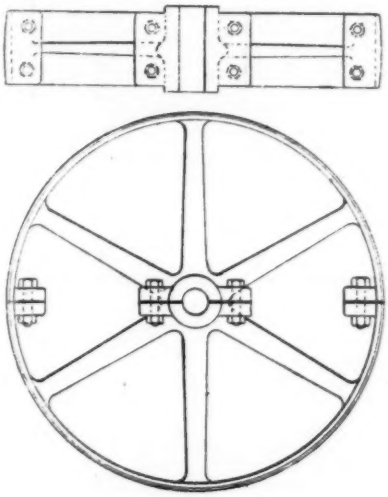


FIG. 11.

The splitting is done by means of a plate of wrought or of cast iron covered with some preservative against the heat of the metal, which without this coating would partially fuse the plates. For light pulleys, sheets of wrought iron are used, for heavy ones cast iron is often employed, as being less liable to cause blow holes. Thin loam is sometimes used for covering the heavier plates, but for the lighter ones ordinary wet blacking or gas tar, or even oil are employed. One important point is to bring the metal into the mould as far away from the plate as convenient. Thus in the case of a pulley, instead of pouring in the boss, the metal should be brought into the rim through two or three thin runners in a position midway between the splitting plates, so that the metal shall simply rise up round the plates without beating against them; and further, the metal should not be any hotter than necessary for proper running. Neglect of these points will cause blow holes and partial fusion of the plates, so that it will be difficult or impossible to withdraw them from the parting. The plates are prepared from templates made by the patternmaker, with the bolt holes bored through them.

The bolt holes are almost invariably cast in the split lugs. Holes are punched or drilled in the split-

ting plates at the same centres and positions as are required in the lugs, and of the same diameter, and through these are thrust the round cores by which the holes are formed. Fig. 16 shows a section A and plan view B of the lug mould against the rim, with the splitting plate and bolt hole cores in place. Fig. 17, A shows a similar sectional view of the boss, and B a plan of the same, being the counterpart in every respect of Fig. 15, bearing in mind, of course, that in any case, the plates would not be lop-sided, but either both like C in Fig. 15, or like C¹. Fig. 18 shows prongs frequently cut on plates to hold them more securely. Fig. 19 gives a view of the pattern boss with its prints A for splitting plates as used when the boss has to be split for binding (Fig. 12), the grooves for the bonds being shown, the prints A moulding, of course, downwards.

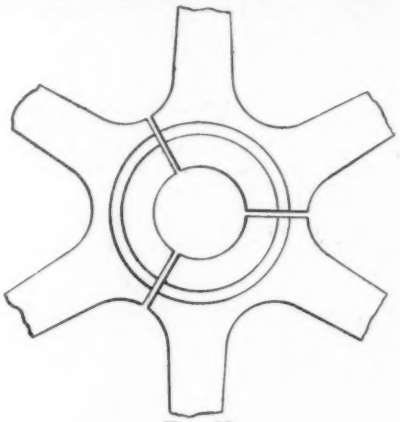


FIG. 12.

FIG. 13.

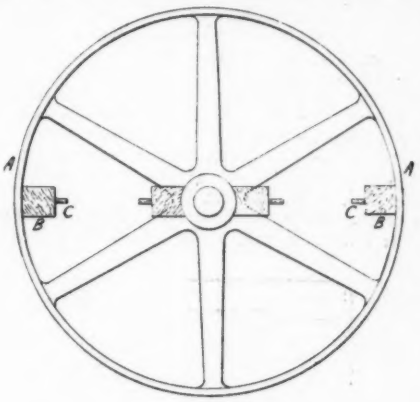


FIG. 14.

The pulley rim should not be divided in casting but the splitting should only be carried through the lug, stopping at the rim. The reason is to prevent distortion of the latter which would occur if the rim were cut through. The rim thickness is either nicked and fractured, or is cut through with a parting tool in a slotting machine. Bosses are not always split right through, but a narrow strip is often left next the bore only, or in that locality, and also on the outer edges of the lugs. These narrow connections either break open as the arms cool, or they are slotted.

When the pulley has cooled, the plates are knocked out, and fresh ones made for permanent use. As the shrinkage of the arms tends to open the joint at the boss the plates there almost always fall out, but those next the rim have to be removed with a hammer, which removal is facilitated by the loam or the blackening breaking of the faces. Sometimes the heat of the metal causes the plate to be partly burnt to the casting. The new permanent plates are of iron, or wood, prepared and bolted between the lugs before the turning is done. In high-class work the bolt holes are frequently drilled in preference to casting. Then they are drilled from the joint of one-half of the pulley, and marked off thence on the other half.

The method of splitting a pulley of small size is necessarily somewhat different from that of larger ones. Thus, it is clear that in the case of the pulley shown in Fig. 20, separate lugs could not be introduced for the boss and for the rim, hence the splitting must be continuous between boss and rim. It is also convenient, because it saves trouble in moulding, to dispense with arms in such a case, and to make a solid-plated centre instead. Fig. 20 therefore illustrates the usual or standard method adopted of splitting small pulleys under from 12 in. to 16 in. diameter, or even some larger ones, and Fig. 21 is the pattern work.

Special pulleys are charged at higher rates than those for which the patterns or pattern parts are standardised. Slight departures from regular diameters are frequently wanted, many differences in bosses, sometimes very large bosses which give trouble

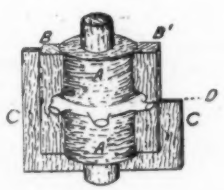


FIG. 15.

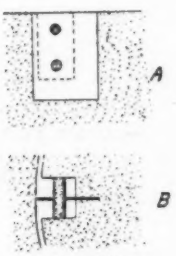


FIG. 16.

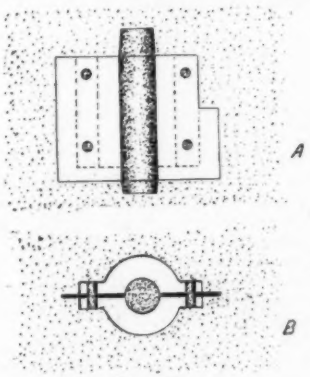


FIG. 17.

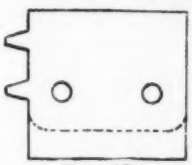


FIG. 18.

FIG. 19.

in cooling, and bosses with flanges. Rims may have to be flanged. The first-named involves the greatest expense and trouble, because a pulley rim costs too much to make for a single order or two, and sweeping up in green sand is also open to objections on the score of expense. In this case the outside would be rammed against a swept block and most of the interior, together with the arms, be formed in cores similarly to flywheel arms. The method which may be adopted is as follows:—

When special pulleys having heavy rims, or rims very much crowned are wanted from the ordinary light and parallel iron pattern rims, the alteration can be easily effected by laying strips of wood against the face on which the alteration is to be effected, and using them as templet guides for strickling off the sand. Fig. 22 shows such strips in section laid against the rim of a pulley. If a pulley is wanted ¼ in. or ½ in. smaller or larger than standard, strips are laid round ¼ in. or ½ in. thick on the inner or outer faces of the rim respectively. If the extra weight is objectionable, then the rim is turned down to remove the excess, either off the outside if the diameter is to be less than standard, or off the inside if larger than standard. As the turning cannot be carried farther inward than the arms it takes the form of a considerable taper from the arms outward to the edges.

Work of this kind is rather risky, because the casting of a heavy rim sets up strains in the arms, and the turning down of a heavy rim sets up strains in it. In this, therefore, due care must be taken to harmonise proportions between rim and arms.

Bosses of large diameter and unusual length give trouble in cooling. It is easy to fit any bosses with their studs to the hole in the centre of the arms, but the shrinkage strains cause trouble. They have to be used often, and then artificial cooling must be resorted to.

Pulleys fracture when badly proportioned. All parts should cool down equally, and this can only occur when thicknesses of metal are not very dissimilar. If the rim is thick the arms must be heavy, and *vice versa*. Heavy bosses are the most frequent cause of fracture. Sometimes they are unavoidable. Then it is desirable to cool the boss as rapidly as possible. In a very few minutes, therefore, as soon as the metal is set in the runners, these are knocked off, the grid bolts unscrewed, the top lifted and the sand dug away around the sides of the boss, and a hole dug from the outside of the box along the floor and under the box to the boss in the bottom. Although the boss is then at a full red heat and requires tender poking at, to avoid fracturing it, the fin spreading over the edges of the rim is already at a black heat and is seen to have contracted sensibly. The object now is to retain as much of the heat as possible in this, and to dissipate that in the boss. As the hot sand therefore is scraped away from the boss, it is shovelled over the rim to a depth of 2 or 3 in. The core is dug out of the interior of the boss, and the hole and the boss face are swabbed with water to hasten the cooling. This chills and slightly hardens the metal for turning, but that has to be put up with for the sake of obtaining a sound casting.

Where pulleys are wanted with flanges, that entails a parting at the bottom as well as at the top edge, and a middle part box. The practice is to keep iron pattern rings to fit on the outside of pulleys, to be rammed up at any depth required to suit different widths of face. If the pattern rims are wider than required, the casting can be turned down, or the excess can be stopped off with a sweep in the mould.

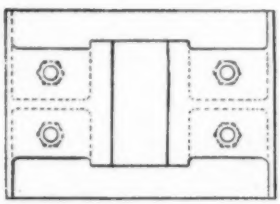
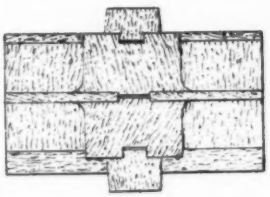


FIG. 20.



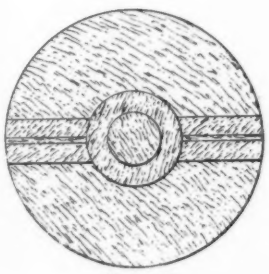


FIG. 21.

FIG. 22.

MICA SCHIST FOR CUPOLA LININGS.—Mr. J. S. Hibbs, assistant general manager of the J. W. Paxson Company, Philadelphia, discussing the subject of cupola linings recently, laid stress on the use of mica schist, which is a natural laminated silicate, not subject to expansion or contraction. It was first used by Bessemer steel-makers for lining converters, but later proved to have great merit for use in cupolas and lime kilns. It costs more to lay, but this is offset by its lasting three times as long as firebrick. It should be laid edgewise, like books on a shelf, otherwise it will spall. The interstices should be filled with the smaller pieces, some of which may be ground, to make a solid wall. Laid in this manner it offers great resistance to abrasion and eventually its surface becomes glazed and smooth. The use of mica schist in cupolas under 35 in. dia. was not recommended.

Foundry Plant and Equipment.

"Sirocco" Cupola Fans.

Without entering into any controversy on the respective merits of positive-pressure blowers and centrifugal blowers or fans for cupola work, it must be admitted that with increasing knowledge of the importance of tuyere area and cupola design generally the demand for the high pressures which called for positive-pressure blowers is practically discounted, and many foundrymen who have always insisted on the value of the fan now find their claims meeting with much more general support. A cupola fan (the "Sirocco," by Messrs. Davidson & Company, Ltd., Belfast) which has found wide application for cupola work is illustrated herewith. "Sirocco" fans designed and constructed to deliver up to 30-in. water gauge.

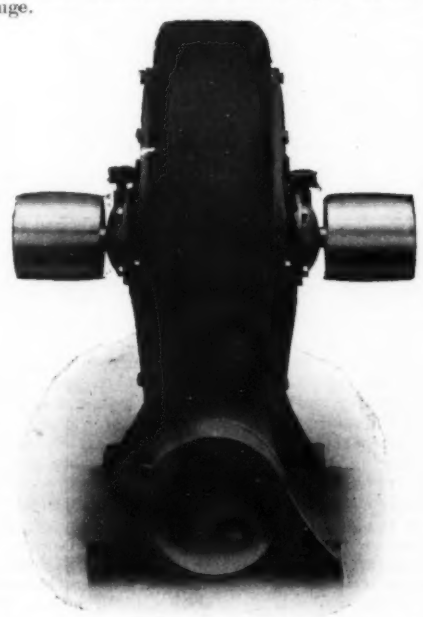


FIG. 1.—"SIROCCO" CUPOLA FAN 20 IN. DIA., SHOWING BOTH PULLEYS.

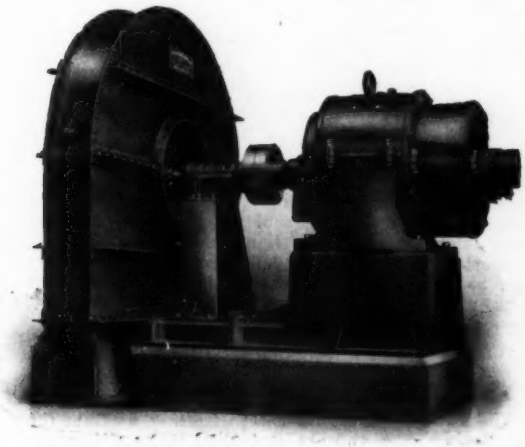


FIG. 2.—SPECIAL STEEL-PLATE "SIROCCO" FAN, DIRECT-COUPLED TO MOTOR.

Among the advantages claimed for these fans over positive blowers are the following:—

Owing to the few wearing parts, the fan is remarkably free from risk of breakdown, and requires practically no repairs except the occasionally relining of the bearings. The mechanical efficiency of the fan is high and remains so, not being affected, as in the rotary blower, by the wear of the impellers and gears. The pressure is steady and can be maintained at any water-gauge required by the majority of cupolas, while the volume is even and free from pulsations. Finally, the weight of the fan and the space it occupies is less than in the case of a rotary blower.

The casing of the "Sirocco" cupola fan, up to and including 35-in. diameter, is of cast-iron, and supported on four feet. The wheel is of the usual "Sirocco" construction and of the double-inlet type. It is rigidly built and carefully balanced to ensure true running. Fans up to and including 35 in. in diameter have ball bearings, which are carried in strong cast-iron brackets bolted to the sides of the casing, thereby ensuring absolute rigidity and permanent alignment. These bearings consist of two hardened steel rings, provided with curved ball races, and each having a double row of balls held in a cage running between them. The rings are of special hardened steel, and treated to ensure absolute uniformity in every individual ring. The balls, correct to one ten-thousandth of an inch, are of high-carbon chrome steel. The cage is of solid-drawn gun-metal. The construction is such that every part of the complete ball bearing is easily accessible for examination. The belt-driven fans are furnished with two pulleys, except the three small sizes, 10, 12½, and 15 in., which have single pulleys. When required, a special countershaft can be supplied, which forms part of the base of the fan, requiring only one belt to connect it to the motive power. When fans are to be direct-coupled to motors, the pulley is replaced by a half coupling, and the fan and motor mounted on separate or combined base-plates according to requirements.

In the table of capacities herewith are given particulars of the sizes of fans required for a stated duty. It should be noted that the fans are, generally speaking, above the duty required, and that it is necessary to fit a blast valve between the fan and cupola, so that the volume may be adjusted to the correct amount, and the power kept to the specified figure. A liberal quantity of air has been allowed in each case, but the exact volume per ton of metal depends on the size of the cupola and on the ratio of coke to metal. The power figures quoted in the table, while having an ample working margin, are intended for a fully-charged cupola—that is to say, when the resistance to the air-blast is at its highest. Should the fan be running when the cupola is loosely charged or empty, this resistance will be greatly diminished, and the volume and power correspondingly greater. This is an important point when the fan is electrically-driven, and users are strongly recommended to put

down a motor with a good margin of power and protect it by using an automatic overload cut-out.

Fans of 40 in. diameter and upwards are furnished with steel-plate casings, as are also special fans of smaller sizes such as, for instance, where a fan is to be direct-coupled to a motor and the fixed speed of the

Table of Capacities of Sirocco Fans.

Tons of metal melted per hour.		Pressure in inches, W.G.									
		12"	14"	16"	18"	20"	22"	24"	26"	28"	30"
5	Diam. of fan	20"	20"	20"	17½"	17½"	17½"	17½"	—	—	—
	Revolutions	2,160	2,320	2,480	3,000	3,200	3,340	3,500	—	—	—
	Horse-power	13.5	16.5	19	20	22	25	28	—	—	—
6	Diam. of fan	25"	25"	20"	20"	20"	20"	20"	—	—	—
	Revolutions	1,730	1,860	2,480	2,650	2,800	2,930	3,060	—	—	—
	Horse-power	16.5	20	22	24	28	32	37	—	—	—
8	Diam. of fan	30"	30"	25"	25"	25"	25"	25"	—	—	—
	Revolutions	1,440	1,550	2.000	2,120	2,240	2,340	2,450	—	—	—
	Horse-power	22.5	28	30	34	38	44	49	—	—	—
10	Diam. of fan	—	—	30"	30"	30"	30"	25"	25"	25"	—
	Revolutions	—	—	1,660	1,770	1,860	1,950	2,450	2,540	2,650	—
	Horse-power	—	—	38	44	52	58	58	62	70	—
12	Diam. of fan	—	—	30"	30"	30"	30"	30"	30"	30"	—
	Revolutions	—	—	1,660	1,770	1,860	1,950	2,040	2,120	2,200	—
	Horse-power	—	—	45	50	57	63	73	83	90	—
14	Diam. of fan	—	—	—	30"	30"	30"	30"	30"	30"	30"
	Revolutions	—	—	—	1,770	1,860	1,950	2,040	2,120	2,200	2,280
	Horse-power	—	—	—	60	66	73	80	86	97	104
16	Diam. of Fan	—	—	—	35"	35"	35"	35"	30"	30"	30"
	Revolutions	—	—	—	1,520	1,600	1,670	1,750	2,120	2,200	2,280
	Horse-power	—	—	—	70	85	93	100	100	106	113
18	Diam. of fan	—	—	—	—	35"	35"	35"	35"	35"	35"
	Revolutions	—	—	—	—	1,600	1,670	1,750	1,820	1,900	1,960
	Horse-power	—	—	—	—	96	106	115	125	135	150
20	Diam. of tan	—	—	—	—	35"	35"	35"	35"	35"	35"
	Revolutions	—	—	—	—	1,600	1,670	1,750	1,820	1,900	1.960
	Horse-power	—	—	—	—	100	112	130	140	150	160

latter necessitates a special size of fan to meet the given duty. The bearings of the steel-plate fans are ring lubricated, lined with white metal and amply proportioned for strength and durability. These fans can be supplied in the same types as the cast-iron fans, viz., undercast, overcast, upcast and downcast.

Gas-Fired Drying Stoves.

The advantages of gas as the heating medium for the drying oven and the annealing stove are generally recognised, and in the large foundry one or other form of producer system might almost be said to be a *sine quâ non*. Whilst economy and efficiency should be the dominating factors of every foundry, they are vital essentials to the medium-sized and small shops; it is therefore surprising to find so many open fires in use in the two last-named. Upon a conservative estimate the saving effected by an efficient producer plant as against the open fire may easily be from 40 to 50 per cent.

We illustrate in Fig. 1 the arrangement of a battery of ovens built for a North-country foundry by Messrs. R. & G. Hislop, Underwood House, Paisley. The gas producer, of special design, is placed at the back, in the position usually occupied by the open fires, and built against the brick wall of the stove. The producer is worked entirely under chimney draft, on which account it is claimed that the best possible efficiency is obtained, whilst there is practically no chance of explosion, which is admittedly not an unknown occurrence with the ordinary pressure producer.

The method of distributing the heats is by means of a chamber constructed inside and extending the full width of the stove, and having a number of pigeon holes for the regulation of the gases therefrom. The stoves are connected to the chimney by suitable flues, the openings in the floor being placed in close proximity to the door. Additional outlets, operated from the front of the stove, are provided in the floor at other points, so as to give speedy ventilation for the large volume of moisture which is given off during the initial period of drying. In cases where the stoves are used for drying on the floors during the day time, a considerable portion of the heat takes to the roof. This is prevented by the employment of a swinging baffle hung from the roof at a convenient distance from the stove door, which serves to deflect the heat on to the cores. In cases where the stoves are very shallow this baffle is not necessary. Another method is to make the stoves say 7 ft. high above the foundry level, and to sink the carriage flush with the stove floor; in this way not only is the heat conserved, but loading and unloading the carriage is facilitated. It is considered to be the best practice to use the stoves as little as possible for the drying of the small cores and to employ separate means for this, such as portable ovens. In a number of installations on the Hislop system a battery of these small core ovens is installed along the side walls of the stove and heated by the same gas producer. In this way the heat in the large stoves is conserved and so effecting a considerable saving in fuel and time.

The construction of the stove roofs and doors on the Hislop system is worthy of note. The roofing over the stoves, which is shown in the illustration, consists of the usual cast-iron beams placed at suitable centres, which form the supports for the arches of re-inforced special cement, the whole of the roof being covered over with sand to conserve the heat. This particular form of roof construction is comparatively light; it reduces to a minimum the tendency of the roof beams to creep on the stove walls and saves the cost of side binders.

The stove doors are of the hanging type, with cast-iron counterbalance weight at back. The doors consist of T-iron framing, the panels being filled in with asbestos sheets, so secured that any one sheet can be removed in a few minutes. Hinged panels are provided at the bottom of the door, opposite the outlets in the floor. At the top of the door a dip plate is provided which engages with a sand seal

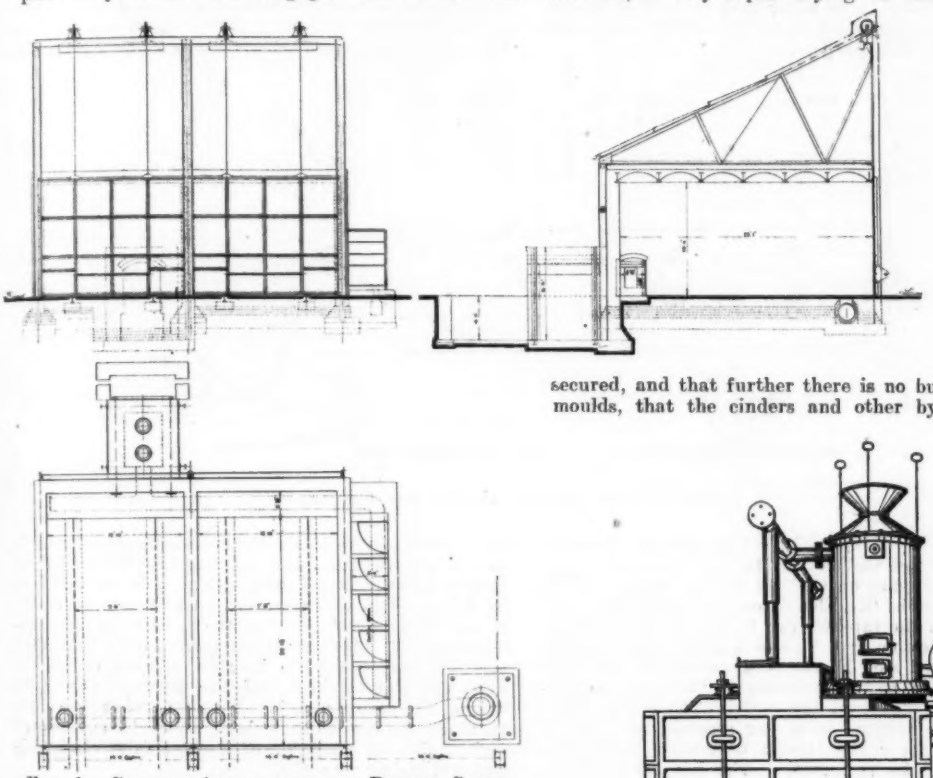
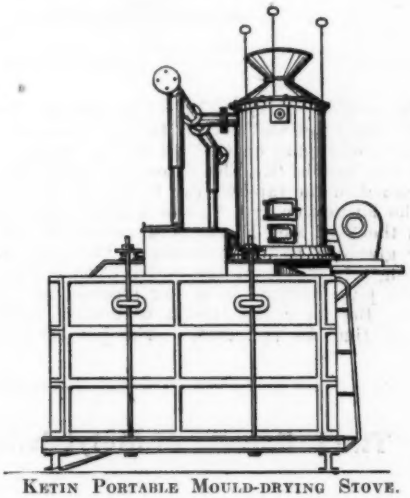


FIG. 1.—GENERAL ARRANGEMENT OF DRYING STOVES.

formed in the front roof beam. The temperature can be regulated to suit requirements and the producer can be completely shut off when desired.

The producers are charged from the top with ordinary gas coke. The cleaning is effected through the bottom door once in 24 to 48 hours, the time taken to clean being from 15 to 20 minutes, whilst during the cleaning process there is no loss of fuel.

As will be seen from the illustration, the heat generator—a coke-burning furnace—is mounted above the stove proper. Once filled with fuel, it requires no further attention. The blast for the combustion of the coke is led in by a series of telescopically-arranged pipes. It is claimed that, as a result of the high and even temperature attained, a very rapid drying of the moulds is secured, and that further there is no burning of the moulds, that the cinders and other by-products of combustion remain in the furnace, and that the stove is extremely economical in fuel consumption.



KETIN PORTABLE MOULD-DRYING STOVE.

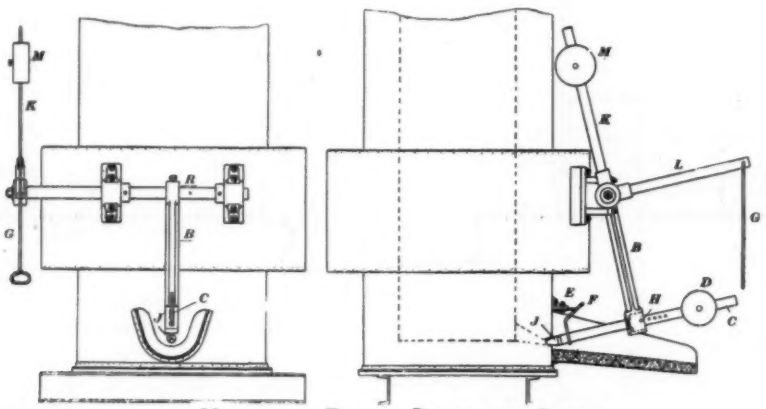
The Ketin Portable Mould-Drying Stove.

A new portable drying stove for use in iron and steel foundries has recently been brought out by a Belgian foundry specialist, M. Alexander Ketin, of Chèm-les-Liege, the object of the design being to overcome the drawbacks of the usual type of mould and core-drying stove in the way of low capacity, high fuel consumption, and heavy maintenance charges. The new stove differs materially in design from the usual pattern, and is of specially strong construction to enable it to withstand a long period of hard use without requiring repair.

Mechanical Tapping Device for Foundry Cupolas.

As in all branches of foundry work there is now a tendency to reduce hand labour to a minimum, it is not surprising to learn that the cupola has been receiving attention, Messrs. Friedrich Feldhoff Sohn, of Barmen, having recently introduced an ingenious mechanical tapping arrangement, which is stated to be the invention of one of their foremen. As will be seen from the accompanying illustration, for which we are indebted to the "Deutsche Giessereitechnik," it comprises a shaft R, supported in two bearings at a height of about 40 in. above the tapping

hole. At right angles to and at one end of the shaft is the operating rod L, and handle G. At the same end is another rod K, with counterweight M. Mounted on the shaft R centrally between the two bearings is the bar B, the lower end of which is shaped to receive a round or square section tap-hole plug C, which is also provided with a counterweight D. The actual plug-carrying piece is made separate from the carrier C, in order that it may be readily renewed when necessary, a reserve supply being kept on hand for this purpose.



MECHANICAL TAPPING DEVICE FOR CUPOLAS.

The method of operation is practically identical with the hand method, all that is necessary being to fix a clay plug on the end of the bar C, and to pull the handle G. The extent to which the plug is pushed in the tap-hole can be regulated by means of the adjustable rod F, which comes into contact with the fixed stop E, the arrangement at the same time giving a bottom pressure to the plug, so preventing any escape of the metal. The plastic mass of the plug hardens in a few seconds, so that by raising the lever the stream of molten metal can at any time be restarted. The provision of the counterweight ensures that the gear is securely held clear of the tapping hole when not in use.

The apparatus is not only adapted for shutting off the stream of metal while the ladles are being changed, but can also be used for opening the tap-hole when the melt is ready, it being then only necessary to fix a suitable tap-hole piercer in the end of the carrier C.

The great advantage claimed for the arrangement is its simplicity and accuracy of operation, rendering the employment of skilled workmen unnecessary; it can be worked without inconvenience even in the hottest weather, and obviates the danger of injury by burns. Furthermore, it permits the metal to be drawn off in much smaller quantities than usual, the waste of metal being at the same time considerably reduced. Another great point is the fact that the workmen stand at the side instead of at the front of the tap-hole and are consequently more out of the danger zone. We learn that the new arrangement has already been fitted to cupolas of various sizes at a number of German foundries, with most satisfactory results.

The Influence of Molybdenum upon the Corrodibility of Steel.*

By J. NEWTON FRIEND, D.Sc., Ph.D., and C. W. MARSHALL (Worcester).

In two recent communications Mr. Thomas Swinden has given the results of a very thorough investigation of the influence of molybdenum upon the physical properties of steel, and it occurred to the present authors that the results might be made still more complete by a careful investigation of the influence of molybdenum upon corrodibility. They desire to express their heartiest thanks to Mr. Swinden for kindly providing them with samples of his steels with which they have been able to carry out the investigation detailed in this Paper. They also desire to express their indebtedness to Messrs. Howell & Company, of Sheffield, who kindly supplied them with carbon steels Nos. 1, 5, and 9, to serve as types. All the steels were tool-turned and cut into cylinders 1.4 centimetre in diameter and 4.0 centimetres in height, and weighed approximately 40 grammes. The surfaces were rendered perfectly smooth with emery. The analyses† of the steels were as in Table I.

Five series of experiments were carried out, and the results are, for the sake of easy comparison, grouped together in Table II. In calculating the corrosion factors for each series the loss in weight of steel 1 is taken as 100.

(1) *Tap Water Tests.*—The samples of steel, resting on discs of paraffin wax, were placed in beakers containing 300 cub. centimetres of tap water, and shielded from light. After forty-six weeks the steels were removed, scraped free from rust, and dried in a steam-oven. They were then weighed, the loss in weight being taken as a measure of the corrosion.

* Read before the Iron and Steel Institute, London Meeting.

† With the exception of the carbon steels Nos. 1, 5 and 9 the analyses are those given by Mr Swinden.

(2) *Salt Water Tests.*—These experiments were carried out in an exactly similar manner to the tap water ones, the liquid corrosive medium being 3 per cent. salt solution.

TABLE I.

Steel.	Carbon.	Molybdenum.	Manganese.	Silicon.	Sulphur.	Phosphorus.
No.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	0.14	0.0	0.339	0.157	0.036	trace
2	0.195	1.030	0.218	0.047	0.025	0.016
3	0.246	2.176	0.216	0.064	0.026	0.015
4	0.190	4.110	0.242	0.036	0.020	0.017
5	0.40	0.0	0.357	0.084	0.042	trace
6	0.445	1.054	0.230	0.087	0.026	0.014
7	0.442	2.181	0.270	0.075	0.025	0.015
8	0.487	4.009	0.292	0.038	0.024	0.016
9	1.04	0.0	0.253	0.081	0.049	trace
10	1.215	1.096	0.250	0.124	0.032	0.017
11	1.210	2.109	0.238	0.071	0.023	0.015
12	1.060	4.019	0.230	0.039	0.020	0.016

(3) *Sulphuric Acid Tests* (0.05 per cent.).—In these experiments the corroding liquid consisted of a solution of 0.5 gramme of sulphuric acid in 1,000 grammes of water. The liquid was frequently renewed.

(4) *Sulphuric Acid Tests* (0.5 per cent.).—In these experiments the corroding liquid consisted of a solution of 5.0 grammes of sulphuric acid in 1,000 grammes of water. The liquid was frequently renewed.

(5) *Alternate Wet and Dry Tests.*—In these experiments the steels were laid upon a perforated disc of paraffin wax suspended in a metal bath, which was alternately filled with water and emptied, as described in a previous Paper.* The steels were thus exposed to alternate wet and dry action.

Discussion of the Results.

An examination of Table I. makes clear the following points:—

(1) Molybdenum up to 4 per cent. does not appear to exert any marked influence upon the corrodibility of steel, when exposed to tap water, salt solution, and dilute sulphuric acid.

(2) The results of exposure to 0.5 per cent. sulphuric acid are almost identical with the mean corrosion factors obtained by the exposure of the steels to the other four corroding agencies listed in the table. This is interesting, because it so frequently happens that the solubility of steels in the stronger solutions of sulphuric acid gives entirely unique results, which are quite untrustworthy guides as to the behaviour of the metal towards neutral corroding agencies.

(3) The greatest variation in the corrosive factors is exhibited in the wet and dry tests, the resistance of the steels greatly increasing with the percentage of carbon (see steels 1, 5 and 9).† The molybdenum, on the other hand, tends to increase the corrosion very markedly. The points are clearly brought out by the

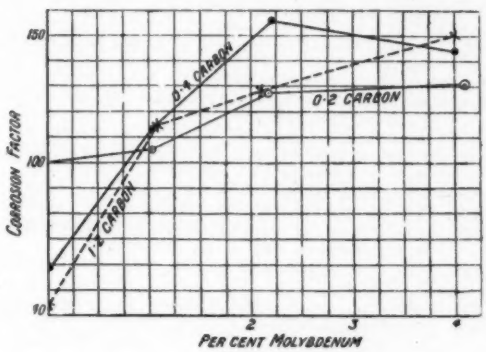


FIG. 1.

curves in Fig. 1. It is difficult to say what conclusions we are to arrive at from this, but if, as the writers believe, the wet and dry tests correspond most closely to the conditions under which steel ordinarily corrodes in practice, it is clear that, from the corrosion point of view, molybdenum is an undesirable constituent of steel if present to a greater extent than 1 per cent.

These conflicting results emphasise still more forcibly the "necessity of determining the corrosion of iron and steel under conditions closely similar to those which the metal will be subjected to in practice."‡

TABLE II.—*The Corrodibilities of Molybdenum Steels.*

Steel No.	Carbon. Per cent.	Molybdenum. Per cent.	Tap water (46 weeks). Loss in weight.	Tap water (46 weeks). Corrosion factor.	Salt water (42 weeks). Loss in weight.	Salt water (42 weeks). Corrosion factor.	Wet and dry (14 weeks). Loss in weight.	Wet and dry (14 weeks). Corrosion factor.	0.05 per cent. Acid (17 weeks). Loss in weight.	0.05 per cent. Acid (17 weeks). Corrosion factor.	Mean corrosion factor.	0.5 per cent. Acid (10 weeks). Loss in weight.	0.5 per cent. Acid (10 weeks). Corrosion factor.
1*	0.14	0.0	0.6478	100	0.6493	100	0.6267	100	0.5906	100	100.0	2.8781	100
2	0.195	1.030	0.6184	95	0.5252	81	0.6500	104	0.5888	100	95.0	2.7990	97
3	0.246	2.176	0.6598	102	0.6494	100	0.7968	127	0.5314	90	105.0	2.8906	100
4	0.190	4.110	0.6540	101	0.6684	103	0.8234	131	0.5834	99	108.5	2.9872	104
5*	0.40	0.0	0.6470	100	0.7292	112	0.3732	59	0.6182	105	94.0	2.9677	103
6	0.445	1.054	0.6200	96	0.6846	105	0.7090	113	0.5600	97	103.0	2.9868	104
7	0.442	2.181	0.6398	99	0.6102	94	0.9776	156	0.5588	95	111.0	2.9726	103
8	0.487	4.009	0.6840	106	0.6436	99	0.9030	144	0.5040	85	108.5	3.0736	107
9*	1.04	0.0	0.6616	102	0.7660	118	0.2756	44	0.6312	107	93.0	3.1117	108
10	1.215	1.096	0.6628	102	0.7016	108	0.7224	115	0.6044	102	107.0	3.1557	110
11	1.210	2.109	0.6790	105	0.6812	105	0.7900	128	0.6046	102	110.0	3.3294	116
12	1.060	4.019	0.6862	106	0.6272	97	0.9486	151	0.6046	102	114.0	3.1286	109

* The results in these horizontal rows are the mean of two sets of experiments.

THE accounts of The Mint, Birmingham, Limited, for the year ended March 31 show that after making provision for bad and doubtful debts, and writing off £2,098 for depreciation, the profit was £20,692, to which has to be added £4,624 brought forward, making £25,316. The directors propose to pay a dividend for the six months ended March 31 of 6s. 3d. per share, making 10 per cent., also a bonus of 5s. per share, and a special bonus of 5s. per share, all tax free, leaving £9,316 to be carried forward. A year ago the dividend was 10 per cent. with a bonus of 5s., less tax, £10,000 being placed to reserve and £5,125 carried forward.

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* "Journal of the Iron and Steel Institute," 1912, No. I., p. 253.

† Contrast the results of Chappell, "Journal of the Iron and Steel Institute," 1912, No. I., p. 270.

‡ "Journal of the Iron and Steel Institute," 1912, No. I., p. 258.

Inventions.

Applications for Patents.

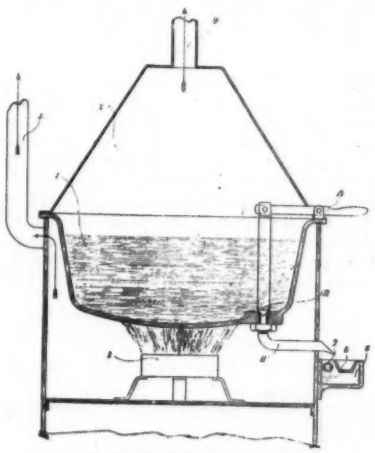
An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicator are in brackets.

8,961. Furnaces heated by gaseous or liquid fuel. L. F. Tooth.
8,991. Furnaces. W. B. Barker.
9,068. Manufacture of iron and steel. G. J. Boyle, Viscount Chetwynd.
10,070.*Moulding-machines. W. Lewis.
10,111. Reverberatory furnace for heating, annealing, etc. C. Glossop.
10,206.*Aluminium alloys. G. K. F. Axberg.
10,208. Foundry riddles. E. W. Beach.
10,538. Manufacture of tinned cast-iron hollow-ware. H. S. Siddons and J. R. Siddons.
10,582. Alloys of which iron is the main constituent. B. Talbot.
10,598.*Furnaces. N. E. Maccallum.
10,792. Moulding-machines. British Thomson-Houston Company, Limited, W. Roxburgh, and J. C. Eaborn.
10,877. Alloys of which iron is the main constituent. B. Talbot.
11,095. Gas-fired furnaces for muffles. J. Church.
11,184.*Means for preventing the formation of poisonous dust in steel-tempering works. H. Brockhues.
11,286.*Method of increasing the rate of transmission of heat in furnaces. A. Poser, O. Strack, and Geb. Stumm, G.m.b.H.
11,350. Apparatus for ascertaining or testing the balance of impeller castings. W. & T. Avery, Limited, and A. W. Brown.
12,011.*Process for rendering high per cent. manganese steel capable of being easily machined. Poldihütte Tiegelgusszstahlfabrik.
12,145. Purification and preparation of metal. F. R. Pope.
12,218 & 21,219. Melting metal in melting-pots. I. Hall.

Abstracts of British Patents Specifications recently Accepted.

6,286 (1913). *Metal Founding.* The British Thomson-Houston Company, Limited, 83, Cannon Street, London, E.C. (a communication from the General Electric Company, Schenectady, U.S.A.).—Metals such as copper and silver are purified by working a mixture of boric anhydride or a suitable borate and an inert material upwards through the molten metal. In this way the flux is brought into thorough and intimate contact with the molten metal, and sound castings of high electrical conductivity can be obtained. During the treatment the metal is preferably superheated, and in the case of copper the preferred temperature is 1,300 deg. C. About two or more parts of boric anhydride B_2O_3, for every 100 parts of metal to be cast, are placed, mixed with some inert material, as charcoal, or even coarse clean sand, in the bottom of a crucible. The copper or other metal is placed upon the mixture, and is then not only melted, but preferably superheated. It should be protected from direct contact with the air by a layer of charcoal. Copper is preferably heated to a temperature of about 1,300 deg. C. The mixture of charcoal and boric anhydride does not rise above the metal even when the latter is melted, due probably to some surface tension effect as it is not wetted by the copper. As the boric acid is thus melted below the copper it may be gradually and thoroughly stirred into the melt to effect purification. A graphite rod is preferably used for this purpose. The charcoal finally rises to the top when the metal is agitated. The melted boric acid also finally floats on the metal. The metal is cast as quickly as possible after purification to avoid further contamination. When copper is treated in this manner, castings having conductivities as high as 90 to 95 per cent. Matthiesen standard may be obtained. Apparently the gases exist partly as a compound of the metal and partly are merely dissolved. For example, oxygen is present as copper oxide and dissolved oxygen in a state of equilibrium. The boric anhydride dissolves copper oxide, and as some is thus removed more is formed, and so on until the copper is purified.

11,843 (1913). *Metal Furnace.* I. Hall, Exchange Buildings, New Street, Birmingham.—The annexed cut is a sectional elevation of a furnace. The metal is passed to the furnace 1 through a door in the upper portion 2, where it is melted by the gas burner 3. The fumes from the metal are discharged by the funnel 4 and the fumes from the gas burner by the the shaft 5. In front of the furnace is a water trough 6 through which water is continuously or intermittently flowing by the pipes 7, this trough containing a mould 8



Metal Furnace, by Hall.

which is pivotally mounted upon a bar and provided with a handle. In the bottom of the furnace is a delivery pipe 11, which serves to convey the molten metal to the mould, the delivery of the metal being controlled by the valve 12 which is operated by the hand lever 13. When it is desired to discharge the metal the lever 13 is depressed which permits the molten metal to pass by the delivery pipe 11 to the mould 8 where it is formed into ingots, the mould being rapidly cooled by the flowing water, allowing the mould to be handled and the ingots discharged therefrom immediately the lever 13 is released.

1,306 (1913). *Manufacture of Steel.* G. J. B. Viscount Chetwynd, Wyndthorpe, near Doncaster.—Molten steel with admixed slag, produced by any process, after being tapped from any furnace into a suitable receptacle in which it forms a deep bath, and before it is run off therefrom into ingot or other moulds, is maintained in such a liquid condition by the aid of an electric current passing through the depth of the bath, and for such a time as to enable slag and other impurities, including gases, in the molten steel to separate therefrom and rise to the surface, and also to enable the purified steel to be still run from the bottom or lower part of the receptacle whilst in a sufficiently liquid condition into the moulds as to produce sound ingots or castings. In carrying out the invention there is passed through the molten steel in the receptacle, a current of electricity of sufficient strength to maintain the steel at the required temperature or even to increase the temperature thereof. For this purpose the bottom of the receptacle is provided with suitable conducting material to form one or more electrodes or poles suitably shaped and adapted for ready connection to and disconnection from an electric circuit. The opposite electrode or pole or electrodes or poles may bt formed by one or more plates, rods, or equivalent of conducting material adapted to be readily placed in such position relatively to the molten metal that upon closing

the electric circuit to which the electrodes or poles are connected an electric current will be caused to pass through the molten steel, substantially throughout its depth, either maintaining the temperature thereof approximately constant, or, it may be, raising it, whilst the slag and other impurities, including gases, are allowed to separate therefrom and rise to the surface, after which the purified steel is run off from the bottom or lower portion of the receptacle into moulds.

23,622 (1913). *Casting Compound Steel Ingots.* H. Martin, 19, rue Pellet, Alfortville, France.—Fig. 1 is a vertical section of the apparatus, and Fig. 2 is a sectional plan on the lines A B. The body of the mould is represented at *a*, the base at *c*, and central and side gets at *d*, *e* and *f*, the mould and side gets being formed of sectional parts connected together in a detachable manner to facilitate the removal of the ingot. The dotted lines *g h* and *i* represent the layers or thicknesses of the two steels and their combination; from *j* to *g* indicating the layer of hard steel, from *h* to *i* the layer of soft steel and from *g* to *h* the layer of steel composed of a mixture of the hard and soft steels, this latter layer

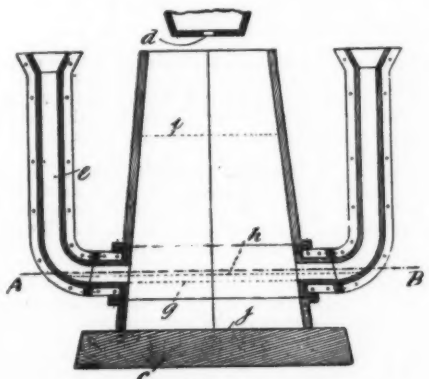


FIG. 1.

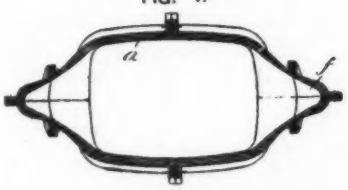


FIG. 2.

Casting Compound Steel Ingots.

being the amalgamating one between the two steels providing perfect homogeneity. The hard steel layer may be poured either from the centre get *d* or from the side gets *e* and *f* until the depth *j* to *g*, or any predetermined depth, is reached, when without ceasing pouring of the hard steel the soft steel is poured either by the same gets *e* and *f* or by other similar side gets until the composite layer of the two steels *g* to *h* is provided, when the pouring of the hard steel ceases and the pouring of the soft steel is continued, until the layer *h* to *i*, or any other predetermined layer, is moulded, when the pouring ceases altogether. The character of the steels amalgamated in layers according to the invention may vary so long as the two are sufficiently different for the purpose for which the metal is intended, such steel as nickel steel, chromo steel, tungsten steel and such like being used as the hard steel layer. The pouring of the softer steel by the two side gets only, avoids the mixing of the two different steels except for purposes of homogeneous amalgamation.

18,116 (1913). *Making or Refining Steel.* E. Humbert, 5, rue du Rossignol, Barleduc, France.—A specific example is as follows, the method being applied to the refining of Bessemer metal containing 0.10 per cent. of phosphorus. Commencing with about three hundred pounds of finishing slag left in the furnace from the previous heat, add about two hundred pounds of scale. Working with approximately the above conditions in a 15 ton Heroult furnace of the arc type it has been found that the slag is kept fluid by the heat of oxidation of the carbide and the patentee has secured a good boil when the Bessemer metal has been poured into the furnace. In ten minutes time the analysis of the metal has shown a practically complete elimination of phosphorus therefrom. The slag is then poured off and a new finishing reducing slag applied which may, for example, consist of about twenty to thirty-five per cent. silica, ten to fifteen per cent. coke dust and the remainder lime and fluor spar.

14,726 (1913). *Melting-pot Furnaces.* V. Coppée, 23, rue Chaudron, Paris.—The bottoms of the crucibles hitherto used, or their walls, rest on supports in the interior of the furnace, so that these crucibles are not free or uncovered at the parts where the action of the flames is the most efficient. This results in a loss of heat. The present invention has for its purpose to avoid these disadvantages; means are provided whereby the action of the flames is uniformly divided over the whole of the surface of the pot, so as to expedite this action and save time and fuel.

A STEEL-TREATING RESEARCH CLUB.—It is announced from the United States that a number of case-hardening and heat-treating foremen employed at the numerous motor-car factories in Detroit and district have organised a society to be known as the Steel-Treating Research Club. Meetings will be held once a month, when metallurgists and men who can impart scientific knowledge on the subjects of case-carburising, the heat treatment of carbon and alloy steels, and various grades of tool steels, will give lectures on those subjects. The Club being intended solely for educational purposes, membership will be restricted to foremen of case-hardening and heat-treating departments, tool smiths, and tool hardeners.

ELECTRIC STEEL FURNACES.—Mr. A. Müller, of Gütehoffnungshütte, in "Stahl und Eisen" states that a Girod furnace has been running for four years, without interruption, at the Gutehoffnungshütte Works. He claims in contrast to many early assertions that this type of furnace is distinguished by great durability of the hearth and simplicity of construction; and that the furnace has behaved admirably in practice. The advantages of the Girod electric arc furnace are that in melting down cold charges it also works as a resistance furnace, in consequence of the passage of the current through the whole mass of scrap, and is of undeniable value as regards the rapid melting down of the charge, especially at the beginning of the smelting process. The slow and continuous leaping of the numerous arcs from particle to particle of scrap proceeds very quietly and without producing any appreciable rushes of current, the result being that the electrodes can be regulated automatically during the longest stage of the melting-down period. In this way the operation goes on very smoothly and in conjunction with the uniformity of current distribution and generation of heat on the steel bath, and also the low tension at the poles, the difficulties of insulation are diminished.

Trade Talk.

J. J. Niven & Company, Limited, engineers, have removed to 38, Lime Street, London E.C.

Messrs. E. G. Appleby & Company have removed to 12, The Broadway, Westminster, London, S.W.

Heavy damage has been caused by fire at the Motherwell works of Hurst, Nelson & Company, Limited.

A fire broke out at Baker's Brass Foundry, Clayton Street, Wigan, but only slight damage was done.

Fraser & Chalmers, Limited, of Erith, Kent, have established a branch at 90, Deansgate, Manchester.

Mr. C. Ewan has taken over the business of Croft & Ewan, engineers, Chapel Yard, Friargate, Preston.

W. H. Allen, Son & Company, Limited, are carrying out considerable extensions to their Queen's Engineering Works, Bedford.

Mr. J. A. Pickard has established himself in business as an analytical and metallurgical chemist at 50, Crooms Hill, Greenwich, London, S.E.

Mitchell, Shackleton & Company, Limited, of Patricroft, Manchester, are carrying out extensive alterations to their Vulcan Ironworks, Monton.

Plans have been passed by the Coventry Town Council for extensions to the works of the Coventry Metal and Iron Company, Limited, Spon Street.

Mawdsley's, Limited, of the Zone Works, Dursley, Glos., have appointed Mr. F. J. Lyons-Davis, 23, Victoria Avenue, Cardiff, as their Welsh agent.

The business of Goddard, Massey & Warner, Limited, engineers and ironfounders, Traffic Street, Nottingham, is being offered for sale as a going concern.

The Great Northern Railway Company have decided to transfer their London engineering and repairing shops from St. Pancras to a site near Hitchin.

The Crisp Engineering Company, Limited, is being wound up voluntarily, with Mr. R. Macmeikan, Moorgate Station Chambers, London, E.C., as liquidator.

T. H. Watson & Company (of Sheffield), Limited, Lancaster Street, Sheffield, are now the sole Yorkshire agents of National Alloys, Limited, Ilford, London, E.

An outbreak of fire has occurred in the works of the Progress Steel and Foundry Company, Camlachie, considerable damage being done to the moulding department.

Mr. H. A. Simmonds, brass founder, Goswell Road, and Hall Street, City Road, London, E.C., trading as F. H. Simmonds, has given notice of an intended dividend.

Considerable damage was caused by a fire at Messrs. Robey & Company's engineering works, Lincoln, last month, the roofing of the main erecting shop being destroyed.

The Whitehead Iron & Steel Company, Limited, have now completed the acquisition of about 30 acres of land at Courtybella, Newport, upon which to erect their new works.

The London County Council has accepted the tender of Edgar Allen & Company, Limited, for the supply of steel and iron castings for permanent ways, the value of the contract exceeding £2,000.

Messrs. F. Layfield and W. H. Clegg, carrying on business as engineers, at Briercliffe Road, Burnley, under the style of Bellfield, Clegg & Company, have dissolved partnership.

The business of Messrs. Chambers, Scott & Company, Dalziel Engineering Works, Motherwell, has been converted into a limited liability concern with Mr. Chambers and Mr. Scott as managing directors.

The plant and machinery at the Cambrian Foundry, Aberystwyth, belonging to Mr. W. A. Green, have been disposed of by public auction. No adequate offer was made for the works, which were accordingly withdrawn.

Messrs. Probert & Son, brassfounders, Handsworth Crescent, Hockley, Birmingham, have taken over the business of Messrs. Hardware and Butler, stampers and piercers, etc., Aero Works, Smith Street, Hockley, Birmingham.

Messrs. McKie & Baxter, engineers and boilermakers, of Govan, Glasgow, have bought the goodwill, drawings, patterns, and templates of the late firm of Muir & Houston, Limited, Harbour Engine Works, Kinning Park, Glasgow.

Messrs. G. A. Smith and J. H. Bellamy, carrying on business as engineers, at Havelock Street, Kettering, under the style of the Smith Machine Manufacturing Company, have dissolved partnership. Mr. Smith continues the business.

The shareholders of Chester's Renfrew Engineering Company, Limited, have passed a resolution to the effect that the company be wound up voluntarily, and that Mr. F. Keer, of Crayside, Bexley, Kent, be appointed liquidator.

Mr. J. W. Peterson has retired from the firm of Cribbes & Peterson, engineers, Beaverhall Works, Beaverhall Road, Edinburgh, which will be continued by Mr. George Cribbes, the remaining partner, in his own name at the same address

At a meeting of the shareholders of W. Scott Wallace & Company, Limited, Powderhall Ironworks, Edinburgh, resolutions were passed to the effect that the company be wound up voluntarily and that Mr. Walter Scott Wallace be appointed liquidator.

At the annual meeting of the Sheffield Society of Applied Metallurgy, the Chairman announced that the Council had decided to give a research medal and small grant to any student in the society or in the University who showed sufficiently original work in non-ferrous metallurgy.

The partnership heretofore subsisting between Messrs. H. Haggas, C. W. Smith, F. T. Haggas, and W. Haggas, carrying on business as machine tool makers, at Keighley, under the style of Ward, Haggas & Smith, has been dissolved, so far as concerns Mr. H. Haggas and Mr. C. W. Smith.

Messrs. A. T. Peacock, F. Waller, and A. C. Bird, carrying on business as engineers, at Alma Road, Hinckley, under the style of Peacock & Bird, have dissolved partnership, so far as concerns Mr. A. C. Bird. The business will be continued by the remaining parties as Peacock & Waller.

The shareholders of Thornewill & Warham, Limited, have passed a resolution to the effect that the company cannot, by reason of its liabilities, continue its business, and that the company be wound up voluntarily. Mr. J. E. Pritchard, 115, Colmore Row, Birmingham, has been appointed liquidator. The business is being offered for sale by private treaty.

The firm of A. Cockburn & Company, carrying on business as engineers at the Thistle Vale Works, Gateside Street, Glasgow, of which Mr. P. Cockburn, Mr. A. Sinclair, and Mr. A. O'Beirne were the sole partners, has been dissolved by the retirement of the first-named. Mr. A. Sinclair and Mr. A. O'Beirne, the remaining partners, will continue the business under the same style of A. Cockburn & Company.

It is expected that the Wednesbury Engineering and Metallurgical Institute, now in course of erection by the Staffordshire Education Committee, will be completed in about a month's time. This addition to educational facilities in the Midlands is being provided at a cost of £18,000. Mr. Walter Macfarlane, F.I.C., who has hitherto conducted so successfully the country metallurgical classes, has just been appointed the principal of the new Institute.

The seventh congress of the International Association for Testing Materials will be held under the patronage of H.M. the Czar of Russia, in St. Petersburg, from August 12-17, 1915. Four days will be devoted to the discussion of the most important problems on testing materials. After the congress, extensive excursions in the interior of Russia have been arranged. The offices of the British Section of the Association are at the Iron and Steel Institute, 28, Victoria Street, London, S.W.

Owing to the expansion in their business, Allen Barton & Company, Limited, have found the Heath Charnock Ironworks, Adlington, Lancs., inadequate for current requirements. They have, therefore, taken the Providence Foundry and Engine Works, which adjoin St. Helens Junction Station (previously occupied by Edward Borrows & Son), and are thus excellently situated for the dispatch of goods for either home or export trade.

The new premises are considerably larger than the former works, and the company are, therefore, enabled to substantially increase their output by laying down additional plant.

THE leasehold foundry and engineering works known as the Gwalia Foundry, Llanelly, have been offered for sale by auction, as a going concern, together with the fixed and loose plant. The bidding started at £1,000, and the property was eventually withdrawn at £1,550.

O. H. N. GASES, LIMITED, have built works in Charles Street, Walsall, Staffs., which, in the initial stage, will be devoted to demonstrating in a practical manner improved forms of apparatus for the production of pure oxygen, hydrogen and nitrogen. The management anticipate having the plant in operation within the course of this month.

THE engineering and technological societies in Manchester have separate meeting rooms of their own, and for some time a scheme of co-operation has been suggested, primarily for the purpose of providing a general meeting room and reference library. Since the idea was first mooted by Sir Thomas Holland, it has received considerable support, so much so as to justify a meeting of representatives of the Manchester engineering and technological societies being convened at the headquarters of the Manchester Geological and Mining Society. A resolution was passed that it was desirable to formulate a scheme of co-operation between the engineering and technological societies of the Manchester district to provide a meeting room and reference library.

THE loading of charging boxes and many of the other operations performed by a magnet in a steel works involve the retention of the magnet in a relatively fixed position. It is often the case, however, that a considerable amount of work can be done by a magnet in different parts of the works, in each of which it would not pay to install a separate magnet. In order to take advantage of the magnet in these situations, it is sometimes possible to lay down a complete magnet equipment consisting of a boiler, a steam set and generator, together with jib crane, and this unit can be moved about the yard as required. A complete equipment of this kind has been supplied to a Sheffield steel works by the Witton Kramer Electric Tool and Hoist Company, of Witton.

IN common with other industrial concerns, Cammell, Laird & Company, Limited, have always made provision for rendering first-aid in case of accidents. With a view to ensuring efficient attention in such cases as may arise, a permanent ambulance corps has recently been formed at Birkenhead under the presidency of the managing director, Mr. G. J. Carter. On his suggestion every employé in the firm who has qualified has been made a member of the ambulance corps, an arrangement which admits of accidents being dealt with on the spot as they occur. Well-attended classes have been formed, demonstrations are given weekly, and the practical work is carried out under the supervision of superintendents, whilst captains and lieutenants of the corps are appointed to every department.

A MEETING of engineers, lecturers and students in engineering subjects has been held at Hanley, at which the following resolution was passed:—"That this meeting of lecturers and students of engineering in the county borough of Stoke-on-Trent resolves to form a society to be known as the Stoke-on-Trent Engineers and Engineering Students' Association, the principal aim and object of which shall be the furtherance of technical education for students of all branches of engineering." Mr. F. R. Holt, general manager for Messrs. Kerr, Stuart & Company, was elected the first president, and delivered an address in which he expressed the hope that, as the science of engineering was the one most subject to change of a far-reaching and rapid nature, the aim of the proposed society would be to keep all its members in touch with the latest developments. Mr. Ernest Jolley, B.A., Lecturer in Mechanics and Mathematics at Longton and Burslem, was elected as secretary, and Mr. John A. Hookham, of the N.S.R. Locomotive Works, as treasurer.

WE are informed that Cochrane & Company, Limited, have just blown out, for re-lining, their famous No. 2 furnace at the Ormesby Ironworks, Middlesbrough, after a continuous run of no less than 38 years, dating from May 8, 1876. This is believed to be a record of life for a blast-furnace lining, not only for the Cleveland district, but for the whole world. Over the 38 years the furnace has turned out 1,365,387 tons of pig-iron, and has made Cleveland iron the whole time. It was damped down during the Cleveland miners' strike, the Durham coal strike, the first North-Eastern Railway strike, and the national coal strike in 1912.

HERR KRUPP VON BOHLEN UND HALBACH, the head of the famous German concern, is making a tour of the important shipping and ordnance centres of Great Britain during the third week of June. Herr Krupp's tour will begin at Glasgow on June 15, whence he goes in succession to Newcastle-on-Tyne and Barrow, arriving in Sheffield on the evening of Thursday, June 18, where he will be the guest of Sir Robert Hadfield until the following Saturday. The programme is as follows:—Friday, June 19: (a) Visit to Hadfield's works; (b) visit to Vickers' works; (c) lunch at Cammell's, works visit in the afternoon. Saturday, June 20: (a) Visit to Firth's works; (b) visit to Brown's works; (c) lunch at Brown's.

GERMAN FOUNDRY FOREMEN'S ANNUAL MEETING.—The annual meeting of the German Foundry Foremen's Association was held this year at Durlach (Baden), and was attended by some 200 members. The programme comprised, besides the business meetings, several technical papers, visits to foundries, and excursions to Heidelberg and Speyer, an exhibition of foundry requisites. This exhibition was not held on quite such a large scale this year, no machines being exhibited. The only English firm represented was the Frodair Iron and Steel Company, Limited, London, who showed a good range of the different sorts of special pig-irons they supply, and which attracted a great deal of attention on the part of the German founders, as they continue to pay great and increased attention to the use and addition of special pig-irons for important and intricate castings. In order to show the opportunities placed at the disposal of the German foundrymen, special mention must be made of the visits paid each year to the different works, iron foundries, and machine shops where the very latest in foundry plant and methods can be seen. This year one of the works visited was the important and modern works of the Badische Maschinenfabrik, in Durlach. Judging by the large number of men who took advantage of this opportunity to visit the works and the great interest displayed, the management of this concern must feel that their efforts were rewarded. No trouble or expense was spared by the firm (managing director, engineers, foremen, and many of the workmen sacrificing their Whitsun holidays) to show the visitors everything they made, from the matchmaking machine (one of which cuts 18,000,000 matches in 10 hours) and leather measuring machinery, to the most important items of modern foundry plant, especially the jolting machines. Very great and practical interest was displayed in these jolting machines, which were not only seen under construction, but also in practical use in the foundry. The machines are strongly and compactly built, and no vibration could be noticed when working. Various other foundry machines of modern construction were also seen in practical use. The firm presented each visitor afterwards with a small cast-iron model of their jolting machine, and then entertained the whole company to lunch, where the usual speeches were exchanged. Many a lesson might be learned from these visits and conferences, and members of the B.F.A. will be well advised to attend same, as it would show how firmly the German foundrymen stick together, doing their best to assist each other by exchange of views, and by placing such opportunities of seeing the very latest in foundry plant in use at each other's disposal.

H

Regulations for the Casting of Iron and Steel.

The Secretary of State for the Home Department has issued a notice, pursuant to Section 80 of the Factory and Workshops Act, 1901, to the effect that he has certified the process of casting iron or steel to be dangerous, and that he proposes to make regulations to apply to all factories and workshops or parts thereof in which such process is carried on. The proposed regulations do not apply to the casting of pig-iron from blast furnaces or to the casting of steel ingots.

Any objection with respect to the draft regulations by or on behalf of any person affected thereby must be sent to the Secretary of State within 30 days from June 9. Every such objection must be in writing, and must state (a) the draft regulations or portions of draft regulations objected to (b) the specific grounds of objection; and (c) the omissions, additions, or modifications asked for.

The following are the regulations in detail:—

*Definition.

In these regulations:—

Moulding shop includes that part of the factory or workshop in which the cupola is situated, and all parts in which molten metal is caught, conveyed or poured.

Duties.

It shall be the duty of the occupier to observe Part I. of these regulations.

It shall be the duty of every person employed to observe Part II. of these regulations.

Part I.—Duties of Occupiers.

1. Where iron plates are used in a *moulding shop*, either as gangways or under furnace spouts, they shall be kept constantly dry.

2. Where molten metal is carried by hand between rows of moulds or boxes, a clear passage way, not less than eighteen inches in width, shall be provided and maintained between such rows.

3. Where molten metal is conveyed across an open space, a clear passage way, dry and covered where practicable, shall be provided and maintained between the cupola and the place where casting is done. Provided, however, that it shall not be deemed to be practicable to erect a covered way, if to do so would interfere with operations necessarily carried on in the intervening space.

4. No person under 16 years of age shall convey or assist in conveying molten metal.

5. Requisites for treating wounds and burns shall be kept at hand and be placed in charge of a responsible person.

6.—(*a*) All chains used for lifting or moving any material shall have been tested and shall be periodically examined. They shall be effectually softened by annealing or firing when necessary; and half-inch or smaller chains in general use shall be re-annealed or fired once at least within every six months.

Chains to which new links or rings have been added shall not be used until they have been re-tested.

(*b*) A register shall be kept on the premises, containing the distinctive mark or number of each chain, the date of each test and re-test, the test load, the safe working load, and the dates of annealing or firing.

7. In any part of a *moulding shop* where molten metal is caught, conveyed or poured, adequate protection for the feet shall be provided and maintained in proper order and repair for the use of all persons employed in that part. Such protection shall consist either of boots fitting closely about the ankles and constructed without lace holes or other openings in which molten metal can lodge, or of spats, flaps, or other appliances fitting closely above the ankles and covering all such openings in the boot, shoe, or clog worn by the person employed.

Part II.—Duties of Persons Employed.

8. Every person employed in any part of a *moulding shop* where molten metal is caught, conveyed, or poured, shall, while any of these operations is going on, constantly wear the protection for the feet specified in regulation 7.

* The term "*moulding shop*" to which a defined meaning is given is printed throughout in italics.

The Home Secretary refers to the "Report on Conferences between Employers, Operatives and Inspectors concerning safeguards for the prevention of accidents in iron foundries," which was issued in January last, and states that, in accordance with the recommendation of the conference, he has made the regulations under Section 79 of the Factory and Workshop Act, 1901, to carry out the agreements at which they arrived. The regulations embody those agreements, with the two additions suggested by the superintending inspector who presided at the conferences, in the last paragraph but one of the report.

With regard to regulations Nos. 7 and 8, the necessity of requiring the provision and use of some form of protection for the feet is shown by the large proportion of accidents with hot metal causing injuries to the feet or lower part of the leg, and this was very generally recognised at the conferences, although no actual agreement was arrived at on the point.

In accordance with the requirements of the Factory and Workshop Act, 1901, the regulations are formally issued in draft in the first instance. Should objections of substance be taken to them either by occupiers or workpeople, or any other person affected, these objections will, under the statute, be the subject of full inquiry by a competent person appointed by the Secretary of State, and the report of the person holding the inquiry will be considered by the Secretary of State before the final regulations are made. At the inquiry, occupiers and workpeople, and all others concerned, will be entitled to a full hearing.

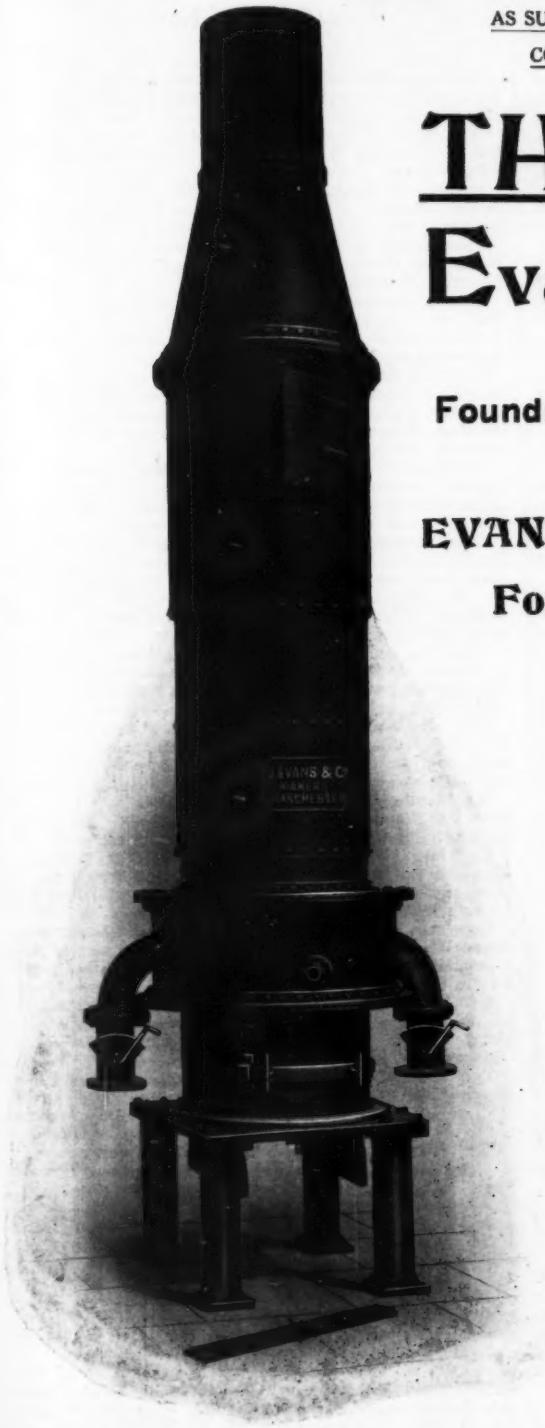
STEEL IN CUPOLA MIXTURES.—Discussing the subject of "Condensed Steel Mixture in Machine-Tool Castings," Mr. H. M. Ramp, in the "American Machinist," claims that the admixture of steel improves the strength, fineness and uniformity of grain and corrects the internal shrinkage of cast iron. In this way the tensile strength is increased more than the transverse strength. According to an accepted formula, multiplying the transverse strength of cast iron by 8.2 will give its tensile strength, but the average of several hundred tests made by Mr. Ramp on cast iron containing 25 to 50 per cent. steel scrap in the mixture shows that this factor would then have to be 10.4. With mixtures containing 5 to 10 per cent. steel, the multiplier 8.2 will remain unchanged. Iron containing 40 per cent. steel scrap broke at 45,000 lbs. per sq. in. with the inch-square transverse bar breaking at 4,050 lbs. The use of steel increases wearing efficiency and in quantities of from 5 to 10 per cent. tends to correct the evils of internal shrinkage. Some of the disadvantages in the use of steel scrap in cast iron, according to Mr. Ramp, are:—(1) If the silicon is low it will set up high shrinkage in the gates and risers and in the castings themselves. (2) If the phosphorus is low the iron will lose its life more quickly than iron of the same composition without steel and will not run so well. (3) It develops a greater degree of hardness in the presence of sulphur and appears to absorb more sulphur during the melting process, due, however, to possibly the use of more fuel necessary to melt and reduce it. (4) It increases the contraction of cast iron from the pattern size. The size of the steel scrap plays an important part. Steel of as light a section and as uniform in composition as possible should be used. Ten per cent. more fuel is necessary than in an ordinary heat, and the steel should always be charged first, for the greatest benefit of the heat is thus obtained and the melting iron dripping from above aids in the dissolving. It is of great importance that the iron be not used until a full charge is collected in one ladle.

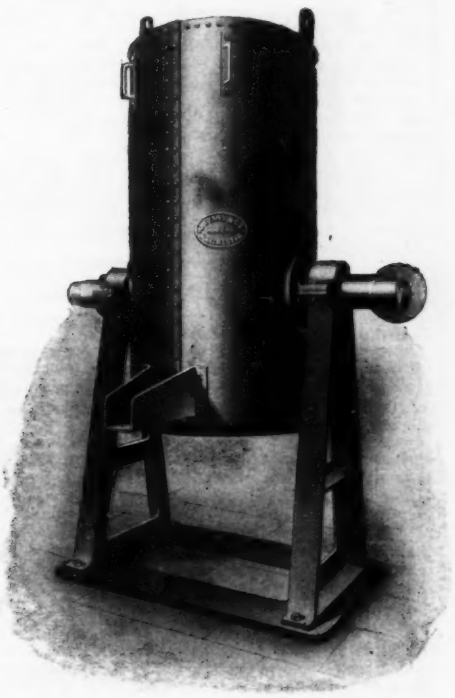
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola. Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE For Emergency Work.





James Evans & Co.,

Britannia Works,

Blackfriars,

MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Telephone: 2297 CENTRAL, MANCHESTER.

x 2

Deaths.

THE death has occurred of Mr. A. Welsh, jun. of Messrs. A. Welsh & Company, Carrick Brassworks, Ayr.

MR. J. SOUTHERN, engineer of the Solway Ironworks, Maryport, has been killed at the works as the result of an accident.

MR. W. BROWN, principal partner in the firm of Brown, Duncan & Company, ironfounders, Bootle and Liverpool, died recently at the age of 73 years.

THE death is reported of Mr. W. Wainwright, of Messrs. Thos. Wainwright and Sons, Commercial Ironworks, Canal Street, Stalybridge, at the age of sixty-four years.

THE death is reported of Mr. T. Crossley, owner of the Catterall Ironworks, Garstang, Lancs., at the age of 51 years. The deceased gentleman only took over the business from his father some 12 months ago.

THE death was announced at Southsea on May 18, after a long illness, of Engineer Rear-Admiral William Lewis Wishart, formerly manager of the engineering department at Devonport. He was 60 years of age.

THE death has taken place of Mr. J. R. Crosthwaite, a director of the firm of R. W. Crosthwaite, Limited, Union Foundry, Thornaby-on-Tees. He was a native of Falkirk, Stirlingshire, and was 58 years of age. He went to Thornaby in 1878, and was elected an alderman of the first Town Council of Thornaby, on the incorporation of the borough in 1892. Mr. Crosthwaite was twice Mayor, namely in 1899 and 1900, and a Justice of the Peace for the North Riding of Yorkshire.

MR. F. J. TREWENT died at his residence, 13, Elsworthy Road, Hampstead, London, N.W., on May 17 last, in his 64th year. Mr. Trewent, who was the head of the well-known firm of Trewent & Proctor, Limited, consulting engineers and naval architects, of Billiter Buildings, London, E.C., had been in failing health for some months. Mr. Trewent was well known on the Tyne, as, in the early eighties, he was general manager for Messrs. Swan, Hunter & Wigham Richardson, Limited, Wallsend, which firm he left to become general manager for Messrs. Andrew Leslie & Company, Hebburn, where he was for some years until he decided to take up business in London on his own account as a consulting engineer and naval architect. For some time he represented Sir W. G. Armstrong, Whitworth & Company, Limited, chiefly in connection with merchant shipbuilding.

Parliamentary Notes.

Compulsory Co-Partnership.

MR. O'SHEA presented a Bill, on May 5, to enable the Board of Trade to compel the reconstruction of statutory and other companies and business undertakings on a co-partnership basis, and for purposes incidental thereto.

University Engineers and Government Positions.

Replying to MR. ROWLAND HUNT, in the House of Commons, CAPTAIN CECIL NORTON stated that the practice of appointing University men to the engineering branch of the Post Office had been discontinued. "We found that we were not getting a desirable class of men from the universities," said Captain Norton, "and we discontinued it two years ago."

Truck Bill.

The text has just been issued of the Truck Bill, which has been introduced by several Labour Members, and Lord Henry Cavendish Bentinck and Mr. Buxton. The object of the Bill is to amend the Truck Acts by making illegal all deductions from wages and all fines, and to extend the benefit of the Acts to outworkers and certain other classes of people whom the courts have decided are not within them on the ground that manual work is not manual labour. Under section nine of the Truck Act, 1896, the Secretary of State has a general power to exempt any trade or business from the provisions of the Act.

Personal.

THE late Mr. S. A. Edwards, chairman of S. A. Edwards & Company, Limited, left £8,545 gross and £7,242 net.

THE late Mr. D. F. Roberts, of the Gwalia Foundry and Engineering Works, Llanelly, left estate valued at £15,806 gross.

MR. C. N. GOODALL, of Darlington, has been elected resident director of Robert Stephenson & Company (1914), Limited.

THE late Mr. J. F. Macartney, a director of Macartney, McElroy & Company, Limited, consulting engineers, left £64,984 net personalty.

THE Home Secretary has appointed Messrs. R. W. Ball, O. Jones, R. Ping, S. H. Lomas, T. R. Rees, L. R. Sowerby, W. J. Stephens, and R. Williams to be Inspectors of Factories and Workshops.

THE late Mr. Arthur Henry Cooper, managing director of the Partington Steel and Iron Company, Limited, of Irlam, Manchester, and formerly general manager of the Port Clarence Works of Dorman, Long & Company, Limited, left estate valued at £8,630 gross.

ESTATE of the gross value of £224,954, of which the personal estate in the United Kingdom amounts to £223,024, was left by Mr. David Sturrock, of Kelvinside, Glasgow, and of the Carntyne Iron Company.

MR. CHARLES MARKHAM, who has been a director of the Parkgate Iron and Steel Company, Limited, since 1889, has been elected chairman and managing director of the company in place of the late Sir Charles J. Stoddart. Mr. A. W. Dixon has been elected a director to fill the vacancy on the board.

THE late Mr. Walter McGee, of Carnasserie, Paisley, of Walter McGee & Sons, Limited, engineers, of Paisley, left personal estate in the United Kingdom valued at £17,015.

THE late General Sir Henry Brackenbury, of Queen Anne's Mansions, S.W., a director of Hadfields, Limited, who died on April 20 last, aged 76 years, left unsettled property valued at £5,704 gross and £5,422 net.

MR. E. MACPHERSON has been appointed secretary of Merry & Cunninghame, Limited, in room of Mr. James G. Smith, who has retired.

THE late Mr. R. H. Boyd, of Oakshawe, Bearsden, Glasgow, a director of J. & T. Boyd, Limited, Shettleston Ironworks, Glasgow, left personal estate in the United Kingdom valued at £14,161.

THE late Sir Richard Mottram, of Beech House, Pendleton, Salford, a director of Galloways, Limited, and a member of the Iron and Steel Institute, left £9,320 9s. 6d.

MR. G. E. LEWIS, of Everitt & Company, Limited, has been elected vice-chairman of the Iron and General Metal Trades Section of the Incorporated Chamber of Commerce of Liverpool.

THE late Mr. George James Walker, of Hillside House, Portlethen, Kincardineshire, engineer, of the firm of Walker & Duncan, of Aberdeen, left personal estate in the United Kingdom valued at £29,507.

MR. JAMES TAYLOR, who over thirty years ago was in charge of the chemical laboratory at Messrs. Thomas Firth & Sons' works, Sheffield, and has since been Government metallurgist in New South Wales, is now on a visit to Sheffield.

MR. WILLIAM PATTERSON who is retiring from the position of assistant manager at the Elswick Engine Works of Sir W. G. Armstrong, Whitworth & Company, Limited, Newcastle-on-Tyne, has been the recipient of a presentation from the officials and men. Mr. Patterson intends to work up a business of his own as an inspecting engineer.

MR. A. W. SAMPSON, who has been manager of the shipbuilding department of the Fairfield Shipbuilding and Engineering Company, Limited, Glasgow, for the past 14 years, has resigned. Mr. H. M. Macmillan, at present general manager of Messrs. Workman, Clark & Company's yards at Belfast, is joining the Fairfield Company as Mr. Sampson's successor.

New Companies.

Hammond and Jones (Engineers), Limited.—Capital £5,000 in £1 shares. Registered office: 11-12, Fenchurch Street, E.C.

West Central Aluminium Foundry, Limited.—Capital £1,000 in £1 shares. Registered office: 1, Gage Street, Theobald's Road, W.C.

Alexander Smith, Limited.—Capital £500 in £10 shares, to acquire the business of manufacturers of crucibles carried on as Alexander Smith.

F. G. Turner, Limited.—Capital £500 in £1 shares, to carry on the business of engineers. Registered office: Cheapside, Cleveland Street, Hull.

Suffolk Iron Foundry Company, Limited.—Capital £1,000 in £1 shares, to acquire the foundry business carried on by L. J. Tibbenham at Stowmarket.

Harvey & Brookes, Limited.—Capital £100 in £1 shares, to carry on the business of ironfounders. Registered office: 10, Union Passage, Birmingham.

F. G. Turner, Limited.—Capital £500 in £1 shares, to carry on the business of engineers and ironfounders. Registered office: Cheapside, Cleveland Street, Hull.

Paul Tracy, Limited.—Capital £2,000 in £1 ordinary shares, to carry on the business of mechanical and general engineers. Registered office: 5, Castle Street, Finsbury, London, E.C.

Suffolk Iron Foundry Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of ironfounders, mechanical engineers and manufacturers of agricultural implements, etc.

Ferrox Company, Limited.—Capital £2,020 in £1 and 1s. shares, to carry on the business of metal founders, etc. The first directors are K. R. Swan, A. C. Hyde, and L. J. Yeoman.

Steel Castings (Giles Foundry), Limited.—Capital £10,000 in £1 shares, to carry on the business of iron, steel and brass founders, etc., and to enter into an agreement with Giles Foundry, Limited.

Trier Brothers, Limited.—Capital £200 in £1 shares, to take over the business of manufacturing engineers carried on at Cumberland Works, New Church Road, Camberwell, and at Caxton House, Westminster.

W. Wesson & Company, Limited.—Capital £25,000 in £1 shares (5,000 preference), to carry on the business of ironmasters. Registered office: Victoria Iron and Steel Works, Moxley, near Wednesbury, Staffs.

Peckham Truck and Engineering Company, Limited.—Capital £25,250 in 15,000 preference shares and 10,000 ordinary shares of £1 each, and 5,000 deferred shares of 1s. each, to carry on the business of engineers, etc.

Turbine Furnace Company, Limited.—Capital £1,500 in £1 shares, to carry on the business indicated by the title. M. Farrelly is the first secretary. Registered office: Caxton House, Tothill Street, Westminster.

Elson & Company, Limited.—Capital £2,000 in £1 shares, to take over the business of an engineer, coppersmith and brassfounder, carried on by G.

FANS AND BLOWERS AND OTHER FOUNDRY MACHINERY FOR SALE.

BARGAINS FOR PROMPT CASH.

No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11½" discharge.
"B" Roots Blower by Alldays.
Foundry Blowing Fan, 36" impeller, 19" discharge, also 9½" round outlet to fit on same.
14" Schiele patent Blast Fan.
Lloyd's patent Blowing Fan for 50 smiths' fires.
New Roots pattern Blower, 5".
Silent Blowing Fans, 8½", 8" and 9" discharge.
Ball Mill, with drum, 2' 7" and 5' 8" outside by 1' 7" wide.
Improved Foundry Core Ovens, portable type and for fixing in wall.
4' 6" diameter UNDERGEARED LOAM MILL, with stationary pan.

CHARLES D. PHILLIPS,
EMLYN & CENTRAL ENGINEERING WORKS, NEWPORT, MON.

BLOFIL
THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
Unaffected by oil, steam, or water.

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RUDD & OWEN
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Telegrams "Theripnene," Hull.
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GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Thornley at Horninglow Street, Burton-on-Trent, as Elson & Company.

George Maynard, Dickins &Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of engineers, founders, etc. The first directors are G. Maynard and H. Dickins. Registered office: 83, Albion Street, Leeds.

Clements Brothers, Limited.—Capital £1,500 in £1 shares, to take over the business of an engineer carried on by T. Clements, as Clements Brothers, at Red Hill, Dudley. The first directors are T. Clements (permanent director and chairman), G. Clements, and T. Clements, jun.

Noble Brothers, Limited.—Capital £4,000 in £1 shares (2,000 6 per cent. cumulative preference), to take over the business of iron and brass founders, etc., carried on at Cockermouth as T. H. and W. E. Noble. The first directors are R. Millican, T. H. Noble, J. Noble, and W. E. Noble.

Alfred Briggs, Sons & Company, Limited.— Capital £7,000 in £1 shares, to take over the business of textile machine makers, ironfounders, etc., carried on at Caledonia Mill, Birstal, Gomersal, as Alfred Briggs, Sons & Company. The first directors are A. Briggs, F. Briggs, H. Briggs and J. C. Briggs.

General Foundry and Engineering Company, Limited.—Capital £2,500 in £1 shares, to adopt an agreement with J. Livingston. The first directors are J. Livingston, D. Mitchell, R. Duffus, P. H. Wardlaw, and J. H. Castell (all permanent, subject to holding £50 shares). Registered office: Lutterworth.

British Engineering Standards, Limited.—Capital £5 in £1 shares, to prepare and promote the general adoption of standard designs, specifications and quantities in connection with engineering materials and works. The first director is C. Dresser. Registered offices: 28, Victoria Street, Westminster, S.W.

Invetrol Lighting, Limited.—Capital £3,000 in £1 shares, to take over the businesses of engineers, etc., carried on by W. Hartley at Derby Street, Burton-on-Trent, and elsewhere, as the Invetrol Gas Light Company, and by J. T. Shakespeare at Bracebridge Street, Birmingham, and elsewhere, as Neville & Company.

F. C. Dutton, Limited.—Capital £5,000 in £1 shares, to take over the business of an agricultural engineer, implement, machinery and horticultural and other tool manufacturer and merchant, carried on by F. C. Dutton at Horsemarket Street, Warrington, and elsewhere. The first directors are F. C. Dutton, F. A. Frost and E. J. Hall.

Powell Brothers, Limited.—Capital £25,000 in £1 shares (12,500 cumulative preferred) to take over the business carried on at the Cambrian Iron Works, Wrexham, by J. E. Powell, R. J. Powell and J. W. Powell as Powell Brothers and Whitaker, and the business carried on at 6, 7 and 8, Town Hill, College Street, Abbot Street, and Beast Market, Wrexham, by J. E. Powell and R. J. G. Powell. The first directors are J. E. Powell, R. J. Powell, J. W. Powell and R. J. G. Powell. Registered office: Cambrian Iron Works, Wrexham.

Telegrams: "Logic, B'ham." Telephone: Midland 1896.

USE THE "OXY-ACETYLENE" PROCESS

For the repairs of your faulty Castings.

Makers of Complete Plants.

McGOWAN, WILD & COMPANY,

206, Hurst Street, Birmingham.

TRADE SIROCCO MARK

CUPOLA FANS.

Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

Double Inlet. All Types of Discharge.

Write for Bulletin No. 2028F.

DAVIDSON & CO., LIMITED,

Sirocco Engineering Works,

BELFAST.

ELDER'S FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time. We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., Ltd. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Copy of an actual test made by one of the principal Railway Companies as to its efficacy, the original of which can be produced for inspection if necessary :—

DESCRIPTION OF COKE.	COKE USED.			PERCENTAGE OF METAL USED.		Pressure of Blast in Inches.	Time Cupolas in Blast.	Average Metal Melted per hour.
	Total Metal melted down.	For Lighting up coke.	For Melting Coke.	Including Lighting.	Excluding Lighting.			
	CWT.	CWT.	CWT.	LBS.	LBS.	INCHES.	H. M.	CWTS.
ELDER'S ..	804	14	64	10.86	8.91	16	3 17	244

Elder's Collieries, Ltd., Cardiff.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-Iron.

Cleveland.

	June 11. s.	d.
Cleveland No. 1	54	0
,, No. 3	51	6
,, No. 4 foundry	51	3
,, No. 4 forge	50	9
,, Mottled	50	6
,, White	50	6
East Coast hematite, mixed Nos.	60	0
Cleveland warrants	51	3

Above prices are for early f.o.b. deliveries, and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s.	d.
Standard Foundry (Glasgow Market settlement price)	50	10½
Warrants, ditto	57	3

Makers' prices:—	s.	d.		s.	d.
Gartsherrie No. 1	68	6	No. 3	63	6
Coltness No. 1	—		No. 3	—	
Summerlee No. 1	68	6	No. 3	63	6
Langloan No. 1	68	6	No. 3	63	6
Calder No. 1	68	6	No. 3	63	6
Clyde No. 1	68	0	No. 3	63	0
Carnbroe No. 1	66	6	No. 3	62	6
Monkland No. 1	62	0	No. 3	60	6
Shotts No. 1	68	6	No. 3	63	6
(All deliverable alongside Glasgow.)					
Glengarnock No. 1	71	0	No. 3	66	0
Eglinton No. 1	62	0	No. 3	61	0
(All deliverable alongside Ardrossan.)					
Dalmellington No. 1	63	0	No. 3	61	0
(Deliverable alongside Ayr.)					
Carron No. 1	69	0	No. 3	64	0
(F.a.s. Grangemouth.)					

Lancashire.

	s.	d.	s.	d.
Lancashire No. 3 foundry f.o.t.	—		55	0
Lincolnshire No. 3 foundry	—		55	9
Derbyshire No. 3 foundry	—		56	6
Staffordshire No. 3 foundry	—		55	6
Cleveland No. 3 foundry	60	0	60	8
(All delivered equal Manchester.)				
Scotch No. 3 Gartsherrie	66	6	67	6
Scotch No. 3 Glengarnock	65	0	70	0
Scotch No. 3 Eglinton	—		64	0
Scotch No. 3 Summerlee	66	0	66	6
(Delivered Manchester Docks.)				

North-West of England.

	s.	d.	s.	d.
Bessemer mixed numbers net f.o.b.	64	0	65	0
Hematite warrant net cash	—		61	0
Lorn cold-blast charcoal iron	—		200	0

The Midlands.

	s.	d.	s.	d.
Staffs. Common forge	50	0	51	0
Staffs. Part Mine forge	51	0	52	0
Staffs. Best All Mine	85	0	90	0
Staffs. Cold Blast	—		125	0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	51	0	51	6
North Staffs. foundry	61	0	62	0
Derby foundry	58	0	59	0
Nottinghamshire foundry	66	0	67	0
Leicestershire foundry	—		59	0
Shropshire Cold-Blast	—		125	0

(Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s.	d.	s.	d.
Forge	—		50	0
Grey forge	—		50	0
Basic	51	0	52	0
No. 3 foundry	51	0	52	0
No. 4 foundry	50	6	51	0
F.o.t. Makers' works.				

South Wales.

	s.	d.	s.	d.
Welsh Hematite	—		65	0

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£	s.	d.	£	s.	d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	21	0	0			
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	19	0	0			
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	17	15	0			
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	49	15	0			
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	0	10	0			
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit. Per ton	10	15	0			
Ferro-titanium: 15/18%, per pound, flat	0	0	6½			
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0	10	9			
Ferro-phosphorus: 20/25%. Per ton	13	10	0			
*Ferro-manganese 80%	9	0	0			
,, export	8	5	0	8	10	0

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£	s.	d.	£	s.	d.
Columns (plain)	7	7	6 to	7	12	6
Pipes, 1½ to 2½ in.	6	5	0	6	10	0
,, 3 to 4 in.	5	17	6	6	0	0
,, 5 to 8 in.	5	12	6	5	15	0
,, 10 to 16 in.	5	15	0	—		
,, 18 to 24 in.	5	15	0	—		
Chairs	4	5	0	4	6	0
Floor plates (open sand)	3	10	0	3	12	6
(At works.)						

Non-Ferrous Metals.

	June 12. £	s.	d.
Copper.			
Standard Cash	61	16	3
Three months	62	7	6
Electrolytic	64	10	0
Tough	66	15	0
Best selected	66	15	0
Tin.			
Foreign Straits Cash	139	10	0
,, Three months	141	5	0
English Ingots	142	10	0
Bars	144	0	0
Refined	146	10	0
Spelter.			
Silesian	21	10	0
Specials	22	11	3
Hard	18	17	6
British	22	5	0
Lead.			
Soft foreign	20	0	0
English	20	5	0
Antimony.			
Regulus	27	0	0
Aluminium.			
Virgin Metal, 98/99% per ton	85	0	0
***Chromium (Metallic).**			
98/99% purity per lb. 2s. 4½d to	0	2	6
***Nickel.**			
In cubes, 98/99% purity Per ton	169	0	0
***Tungsten Metal Powder.**			
96/98% purity per lb.	0	2	2½
***Molybdenum Metal.**			
96/98% purity.. per lb. 10s. 6d. to	0	11	0
***Cobalt Metal.**			
97% purity per lb. 6s. 9d. to	0	7	0
Quicksilver.			
75-lb. bottle	7	0	0

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.	s.	d.
Steel scrap, heavy melting	46	0 to	48	0
Iron scrap cast (cupola metal)	53	0	55	0

London (f.o.b.).

Heavy steel	42	0
Light ,,	34	0
Heavy cast	46	0

Non-Ferrous Scrap.

London merchants quote, delivery free, and subject to market fluctuations:—

	J. B. Garnham and Sons. £	s.	d.	A. Joseph. £	s.	d.
Brass	41	0	0	41	0	0
Clean copper	58	0	0	58	0	0
Brazier copper	53	0	0	52	0	0
Old lead	17	0	0	17	15	0
Tea lead	—			16	5	0
Old zinc	16	0	0	16	0	0
Hollow pewter	90	0	0	90	0	0
Black pewter (shaped)	70	0	0	60	0	0
Gun metal	54	0	0	53	0	0
Aluminium (cast)	—			—		
,, (cuttings)				64	0	0

Stocks.

Pig-Iron in Public Store.

	June 10. Tons.	Inc. + or Dec. − since June 10, 1913. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes	2	−88
Connal's at Middlesbrough	85,619	− 145,830
Connal's at Middlesbrough hematite	—	No change.
West Coast hematite	7,821	−15,485

Metals.

Copper, Europe and afloat	32,970	−8,717
Tin, London, Holland, U.S.A. and afloat	20,039	+5,376

Coke.

Middlesbrough.

	s.	d.	s.	d.
Gas Coke	—	to	12	0
Foundry Coke	—		19	0
Furnace coke	—		17	6

Newcastle-on-Tyne.

FOUNDRY COKE—	F.o.b. Dunston. s.	d.
Original Garesfield	20	0
Mickley	20	0
Stella Garesfield	20	0
Priestman's Garesfield	21	0
Consett Garesfield	20	6
Newcastle gas coke	13	0

Cardiff.

	s.	d.	s.	d.
Special foundry coke	25	0 to	27	0
Foundry coke	20	0 to	23	0
Furnace coke	17	0 to	19	0

Leeds.

Furnace coke	10	9 at ovens.

Birmingham.

Foundry coke	31	0 to	37	6
Furnace ,,	14	6 to	18	6
Gas ,,	14	0 to	15	0

Glasgow.

Foundry coke	—	to	27	0
Furnace ,,	—	to	18	0
Gas ,,	10	0 to	10	6

London.

Foundry coke	27	0 to	28	0
Gas ,,	19	6 to	20	0

Established 1863.

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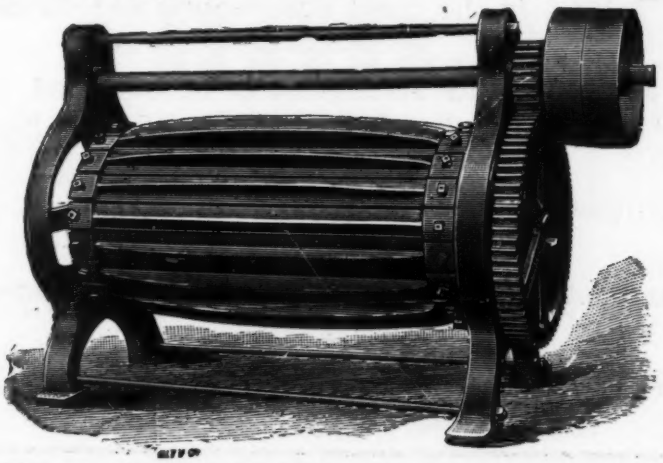

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When mixed with facing sand produces an ART bloom upon every casting.

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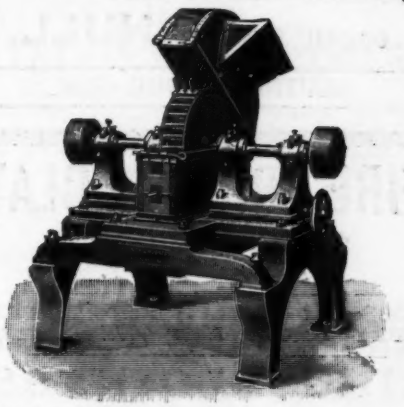

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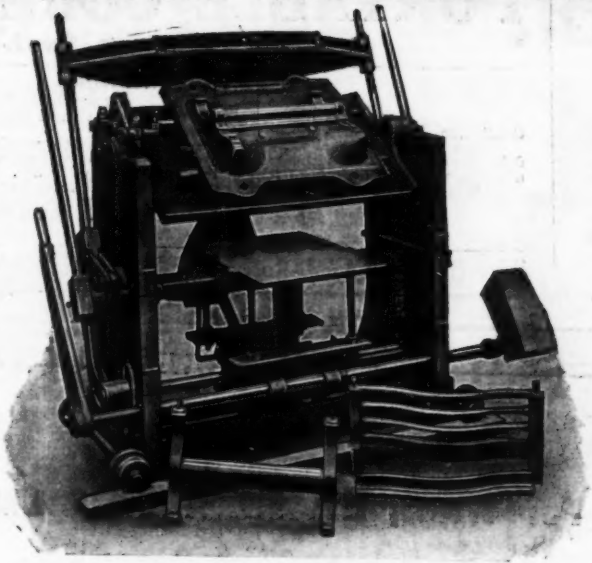

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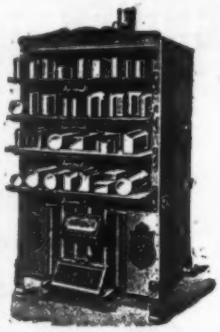

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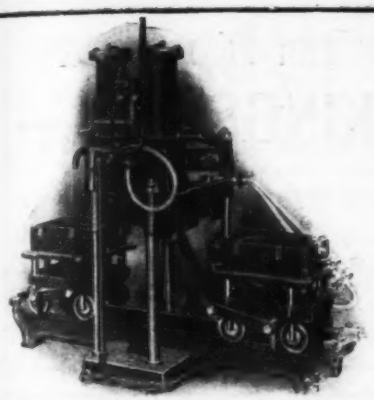

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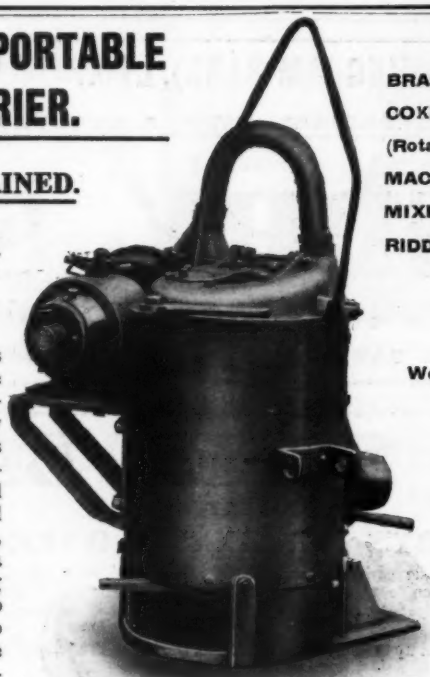

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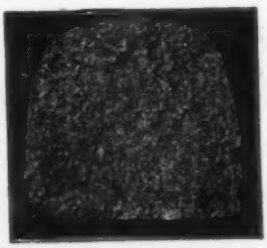
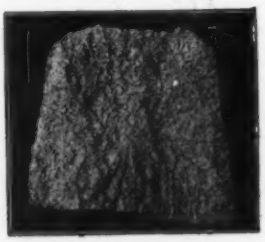
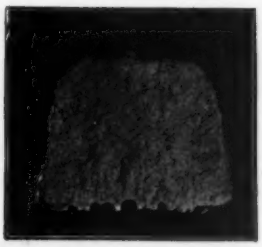

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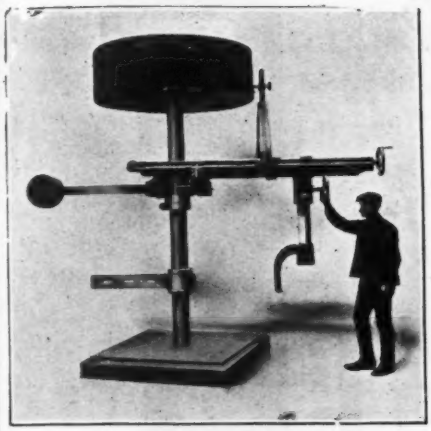

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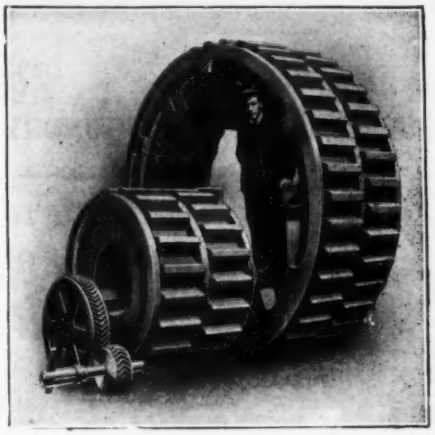

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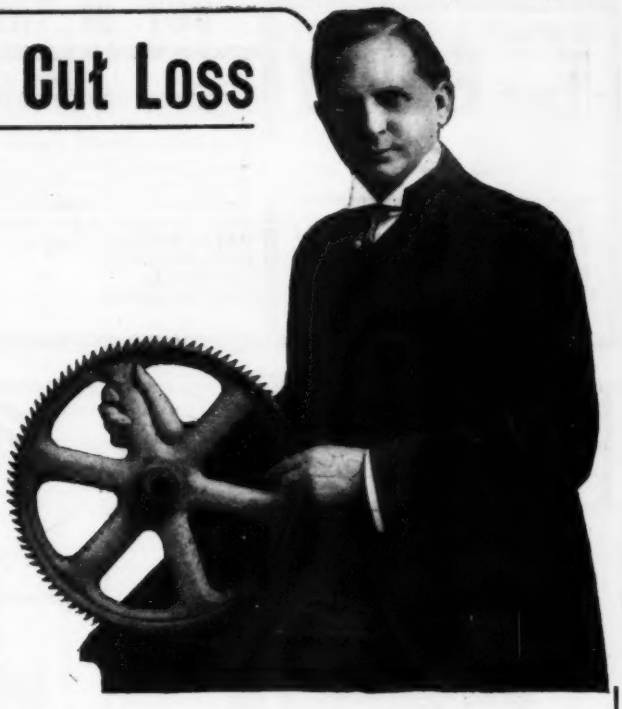

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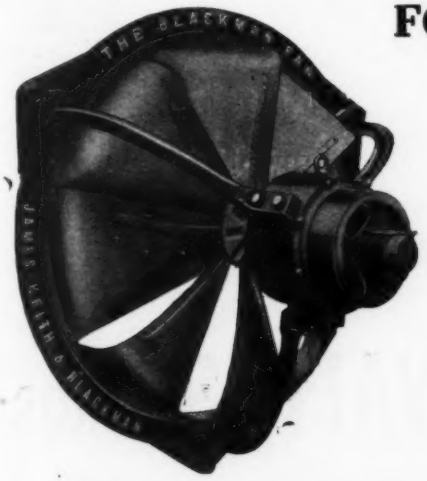

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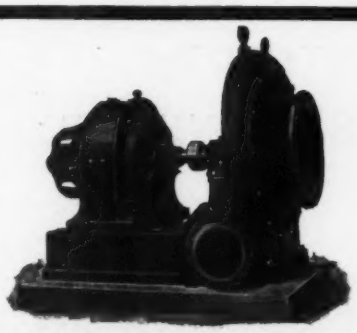

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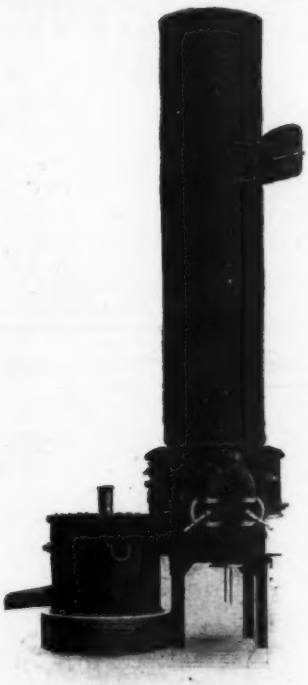

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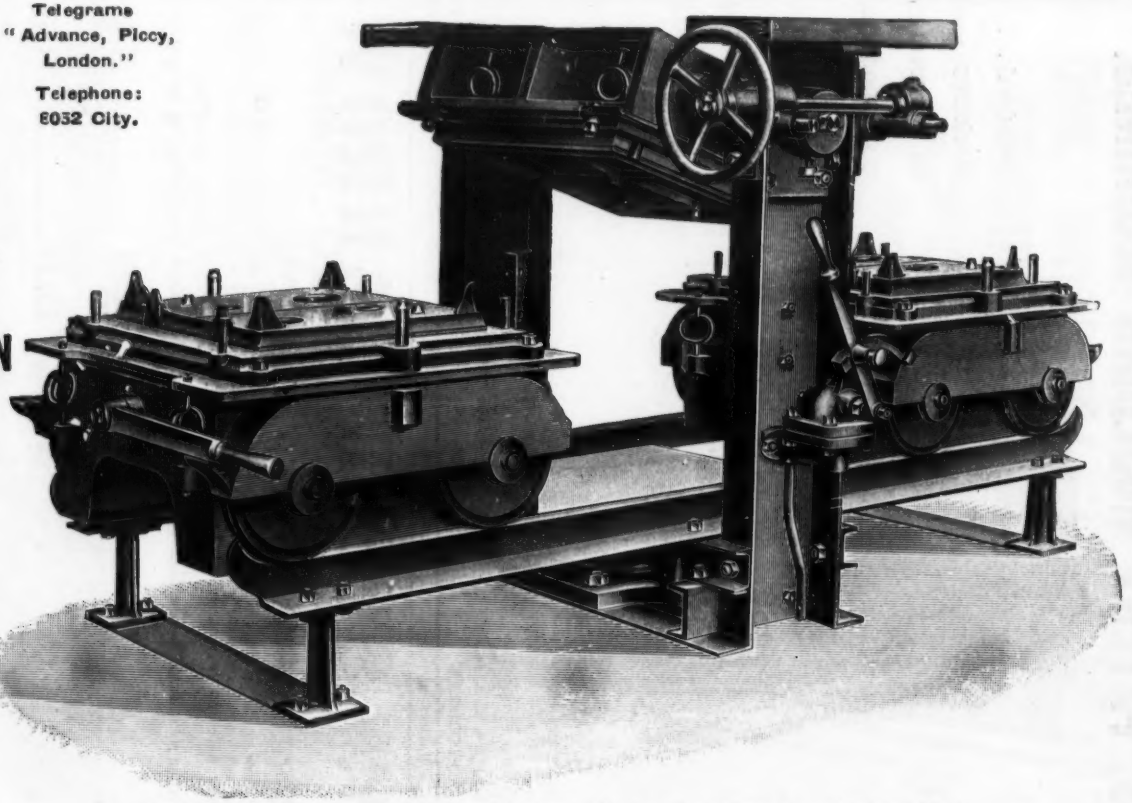

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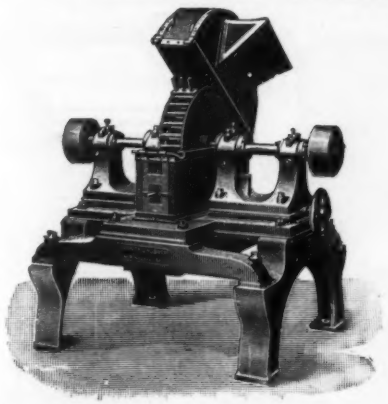

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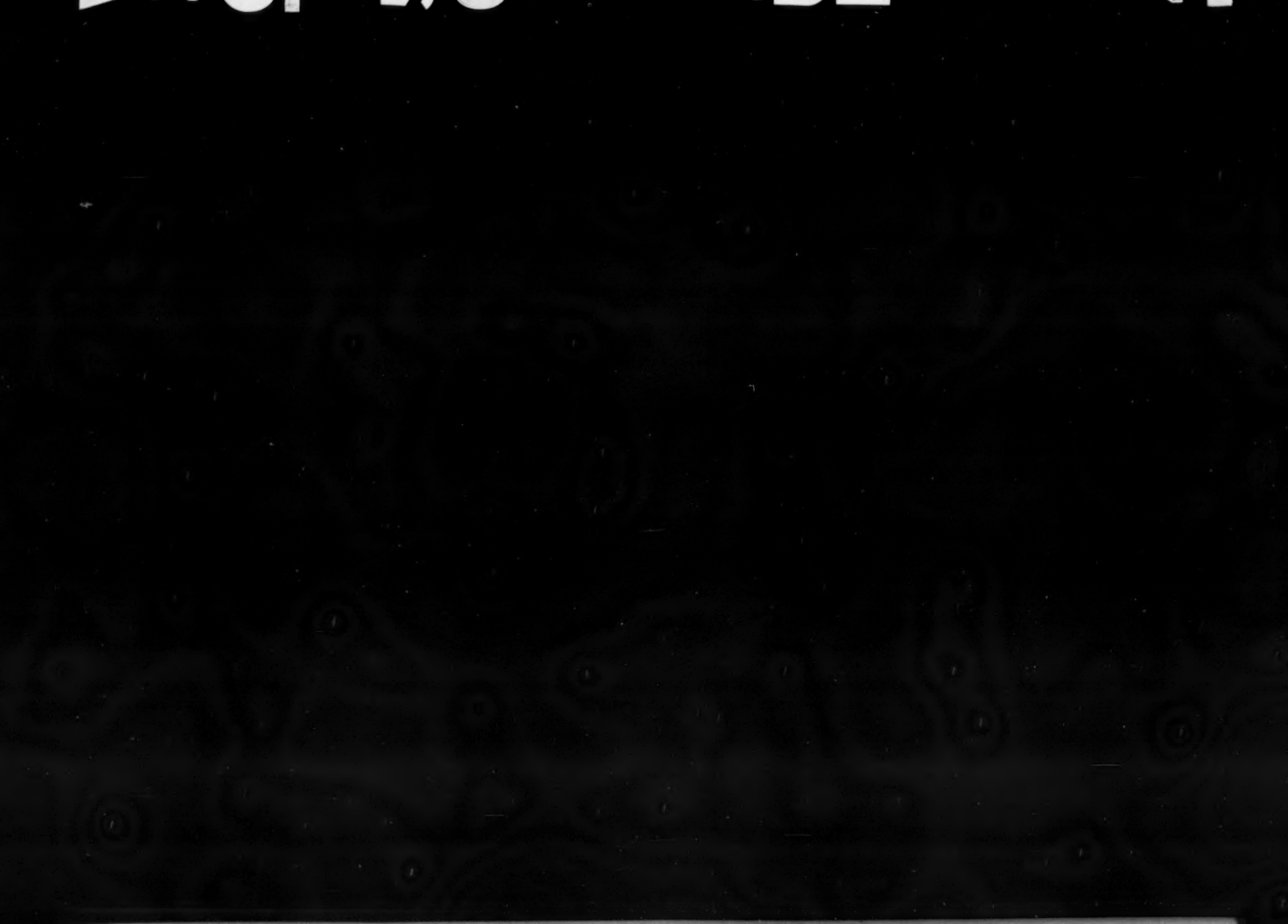
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